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# A catalyst for innovation: research & development at Heidelberg

Tasks, processes and definitions – basis paper looks at innovation management in the print technology group

Innovation is the key to a company's commercial success, and research & development (R&D) is the heart of innovation. Heidelberg – the world's market leader in sheetfed offset printing systems – every year invests more than 6 percent of its sales, i.e. more than € 200 million, in maintaining and extending its innovation strength.

The core business of Heidelberg is sheetfed offset presses in format classes A3 (35x50 cm), A2 (50x70 cm) and A1+ super format (70x100 cm). These format classes are positioned at the very center of the process and value added chain. However, the focus on what comes before and after is increasing all the time. With this in mind, Heidelberg not only offers presses but also machines for printing plate manufacture, finishing equipment and software components for integrating the full sweep of printshop processes. This requires complex interaction between hardware, software and brainware.

The role of research and development at Heidelberg is to enhance this end-to-end workflow by providing innovations that make it better, more effective and faster. How does development take place at Heidelberg? What is developed? Who is involved in the process? This text gives an insight into the research and development process at Heidelberg, introducing the different departments and their core areas of expertise, and to show how teams interact within this high-tech organization. It will provide an example of the complete workflow by depicting a production chain that consists of the Suprasetter platesetter, the Speedmaster XL 105 press, the Dymatrix diecutter and the relevant integration software from the Prinect workflow. The sections of the text dealing with the research involved in this example workflow and descriptions of this practical example appear in *italics*.

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If you require any additional information or have any ideas or questions, please contact the Heidelberger Druckmaschinen AG press team.

# “Innovation is our lifeblood”

The Heidelberg Management Board member for Engineering and Manufacturing, Dr. Jürgen Rautert (pictured), discusses the aims of research and development, management of the creative processes and the features that make Heidelberg stand out from its competitors.

**The world’s market leader in sheetfed offset printing systems spends six percent of its sales revenue – more than €200 million per year – on research and development. This is invested in prepress, press, postpress and process networking projects.**

- **Dr. Rautert, why does Heidelberg undertake research and development?**

Wwe want our success to continue far into the future. Technical products and innovations are our very lifeblood – and they can only be created through research and development.

- **How long would the group’s success continue if it were to shut down its R&D department today?**

Not even one year. We attend trade fairs every year, and in those years when we haven’t had any innovations in our product range, the effect on our sales figures is apparent immediately. If Heidelberg fails to introduce a sufficient number of innovations at the appropriate fairs, the impact on our business growth will be immediate.

- **Is there scope to increase spending on R&D?**

Temporarily, yes. We invested more than 10% R&D into renovating a postpress site, for example. The new products we’ve launched onto the market are the result of this investment. We are not bound by percentages. Instead, we adjust our R&D spending to fit our strategy, which is designed for long product cycles. Heidelberg is proud of the fact that we have continued to invest even during economic slumps. For example, we launched the Speedmaster XL 105 onto the market following a three-year slump in the graphic arts industry. This press enjoyes considerable market success. Were it not for our brave investment policy, we would have fallen behind the competition.

- **Is there any prospect of cutbacks in R&D spending?**

We must continue to work on increasing our productivity in the R&D process, i.e. to increase innovation with the same level of investment. The company may also take a more critical view of its priorities in difficult years. However, too rigorous a policy would have a negative effect on Heidelberg’s revenue and lead to concerns about whether we would be capable of regaining our advantage. After all, the printing market is highly competitive. Printshops invest primarily to enhance the performance of their press systems and to set themselves apart from their competitors. If our products fail to deliver an edge in quality, price and performance, our customers will look elsewhere.

- **What significance does it have when press output is increasing but the market is struggling with overcapacities?**

That means our market share has to increase. After all, the value of presses with a greater

capacity is also increasing and that is the figure we're interested in. If we increase productivity by 30 percent, we can increase the price of the product by 15%. We share the benefit of increased capacity with our customers. It's also worth noting that capacity utilization has increased significantly after three difficult years.

- **What sort of developments bring about unique selling points?**

Anything that leads to a measurable increase in the customer's output. We don't just carry out technical development for the sake of it, but to create presses, software and consulting that enable our customers to increase their efficiency significantly. We have to be able to prove that there is a return on investment. Customers also have to justify their investments to their banks – think Basel II.

- **Can you outline the major developments in printing at the moment?**

It may seem paradoxical, but there's been little change in the past 20 years. With products, the trend is towards increased color and greater differentiation by means of special effects such as gold coating, blister-packs, coating, lenticular technology and 3D images. The finished product is now more complex and of a higher quality. Some prints look better and more realistic than the original. With presses, the focus is on shortening make- ready times and increasing productivity. There's a difference between driving along the highway at 140 mph in a top of the range car than in a small sports car. With one, you need courage and driving skills, with the other, you simply put your foot down and hold steady on the steering wheel. In press terms, the question is whether you can operate with piece of mind at speeds of 18,000 sheets an hour or whether you are constantly worried about the press failing. Do I need to take extra care when making important settings, or do I have a tolerant press?

- **Can makeready times be shortened by improving organization of the workflow?**

The production of print materials is undergoing a process of industrialization – even in small companies. Effective job scheduling, workflow transparency and costing systems that show the printer the status of each job are now standard fare. This calls for greater streamlining and planning of workflows, color management, precise preliminary and actual costing, a management information system that provides feedback about press statuses, i.e. everything that Heidelberg already offers in its comprehensive Prinect software package.

- **What are Heidelberg's core areas of expertise, particularly in terms of this industrialization process?**

Our number one area of expertise is the manufacture of sheetfed offset presses and the ability to ensure precise interaction of many parts in a highly complex design. Then there's our expertise in managing the production of quality large series presses and our highly effective logistics service that extends to the worldwide distribution of original replacement parts. A technical highlight of our work, over and above color management, is aerodynamics, i.e. our ability to transport paper – a delicate material – precisely through a press at high speed. Our logistical expertise is attributable partly to the flexible configuration of our presses. Our series presses have a modular design. On top of this, there's a growing demand for differentiation in the finished products and increasing demand from customers for customized applications. We meet this through our in-house Customizing department, which we have extended considerably in the last few years.

- **Which criteria are used to evaluate research and development?**

Initially, the benefit for the customer, and then also the cost-effectiveness for Heidelberg.

This is documented in a development roadmap that covers the ten years ahead. All development decisions are based on this roadmap. What path is the industry following with regard to formats, colors and applications? What do customers want? What are our competitors doing? What is technically feasible and economically viable? Which area promises the greatest growth – packaging printing perhaps? Last but not least, it's a question of regional priorities. In the mature western markets, we are seeing moderate growth rates and extreme specialization. Volume business is now increasingly coming from the emerging markets in Europe, in Asia and South America. This creates specific conditions, some relating to climatic factors and some relating to application and support requirements.

- **Heidelberg is renowned for the extensive vertical depth of its production. What does Heidelberg develop internally?**

Well, it's worth pointing out that our vertical depth of production is much less than it was 10 years ago. Today, that figure is about 45%, which is largely down to the fact that we are the only press provider that fully develops and manufactures its own control systems. Because of the number of units we manufacture, this brings us significant cost advantages. The level of precision of the mechanical parts in our press design is on a scale of thousandths of a millimeter. Tens of thousands of individual parts have to be integrated with one another and work together. That's where our know-how really comes to the fore. You simply can't buy in that kind of expertise.

- **Do you buy in the software used in the presses and the workflow?**

No finished software is available for them apart from the software developed by us and our major competitors. We supply the Management Solutions, Color Solutions and Production Solutions software used in the Prinect workflows. We have in-depth process know-how in this area thanks to our broad network of customer contacts. This know-how enables us to develop software that has a range of functions and customer benefit unmatched by any other provider. However, we do buy in the operating systems and development environments – it goes without saying that we use the very latest standards.

- **Can you foresee a time when Heidelberg outsources its R&D, or at least part of it?**

I can't envisage any manufacturing company outsourcing its core areas of expertise. On the other hand, it would be madness to claim that we produce everything in-house. We work together with development partners when they have greater expertise in a particular area than us, e.g. colorimeters, water treatment and cooling. But we would be reluctant to let any other company develop critical parts of our presses. A list of criteria has to be met when making outsourcing decisions: Is this a core area of expertise? Will we have an edge over our competitors if we produce it ourselves? We outsource around a third of our development. I can't see that figure increasing much.

- **Can innovation be forced? What conditions foster creativity?**

You can't force innovation, but you can provide ongoing encouragement. You have to be bold enough to accept that a particular percentage of your development investment might not lead to tangible results. But genuine innovation involves breaking new ground and a degree of uncertainty – there's no way of categorically stating the return on investment in advance. Innovation comes from people. What's required is a team of staff with appropriate qualifica-

tions and an environment that fosters creativity.

- **Where does innovation figure in the overall company philosophy?**

Innovation is a top priority. If the board had no interest in innovation, the company would eventually cease to innovate. As long as the board has an interest in innovating, and the expertise and patience required to convince shareholders of its value and to organize it, then the company will be innovative. The seeds are already being sown for 2010. And groundwork is already being carried out in predevelopment to prepare innovations for 2015.

- **You mention the fact that the company has to achieve its objectives and demonstrate success. How can innovation be managed?**

Innovation requires creative freedom, process-free protection zones that foster out-of-the-box thinking. But clearly defined processes are also required to sort good development from bad. By all means, there should be freedom for experimentation, but there should also be early assessment of whether an experiment has potential for success. Imagine the development process as an S-curve – after a difficult start, principles are defined, and work begins to take off. Then, at some point, the growth rates decrease. Eventually, a new development is required to start the next S curve, which normally begins before the peak of the previous S-curve is reached. In other words, I have to know when to stop optimizing an existing product and when to launch into the next radical step.

- **How do you rate Heidelberg's innovative strength and how well does it compare with the competition?**

It's my job to be dissatisfied. Detailed industry benchmark studies show that we're certainly not doing badly. The trick is to be proud of what you've achieved and to promote it assuredly while continuing to innovate relentlessly.

- **Is there any way to shorten innovation cycles?**

One of the main duties of any development team is to tighten its selection criteria. What should we be doing and what not? The more resources you devote to an important project, the shorter the time to market. In the early 90s, it took six and a half years to develop a press. By the late 90s, this had been shortened to four years. Soon, we will reduce this to three and a half years. Among other things, this is a result of new tools such as 3D CAD software. 3D design creation adds to the construction workload, but greatly reduces the effort involved in later stages such as compiling operating instructions or spare parts manuals. And let's not forget qualification of the development procedures. We have to subject large series products to all manner of conceivable application scenarios in scientific tests. Customized products are tested in the company and any required enhancements made on site. It's all about finding the right balance.

- **How do you rate the innovative strength of the printing industry?**

I think it's excellent. The productivity of new press systems doubled for printshops between 1990 and 2000. Advances in technology are continuing, so I would predict a further productivity increase of 80 percent in offset technology between 2000 and 2010.

- **How strong is Heidelberg compared to its competitors?**

Heidelberg is roughly two and a half times the size of its nearest competitor. This relative market share has remained constant for several years.

- **Does Heidelberg have any alternative to the "higher, faster, further" approach?**

No. This is the only means of remaining competitive in Germany and worldwide. That said, we do have to keep an eye on our costs at all times. If one of our competitors manages to achieve 80% of our performance at 60% of our costs, we face a real problem.

- **Heidelberg is setting up a production site in China. Are there plans to develop a press for the low-cost sector there?**

The 250,000 printshops across the world are often depicted in the form of a pyramid, the top of which Heidelberg provides with high-tech products. But when it comes to ability to invest, this pyramid is turned on its head. Worldwide, 20 percent of printshops account for 80% of investment. It makes more sense for us to compete for market share in the high-end sector than to enter a face-off with low-cost manufacturers. So we'll also manufacture high-tech products in China. The advantage is not in the assembly, which only accounts for 15 percent of the overall price. The site in China will only prove to be a sound investment if we can procure our parts at lower cost there. And it's not possible to procure parts without the support of development. For that reason, we plan to set up development capacities there, but there are absolutely no plans to develop a press.

- **What's the outlook for the printing industry in future?**

Viewed from the outside, the printing industry will look virtually the same in the period between 2010 and 2015. The industry will be more intelligent on the inside, however. Fewer staff will be involved in job preparation and press, but still a relatively high number in finishing. The printing process will be largely standardized. Printers will rely on automated measuring processes. Makeready times will fall by 50 percent. There will be greater networking of the process. Manual input will be replaced by automatic feedback of press statuses, which will be transferred automatically to costing. Many printshops will seek to differentiate themselves by offering special services, e.g. logistics, just-in-time delivery, and will use their channels for a wider range of purposes.

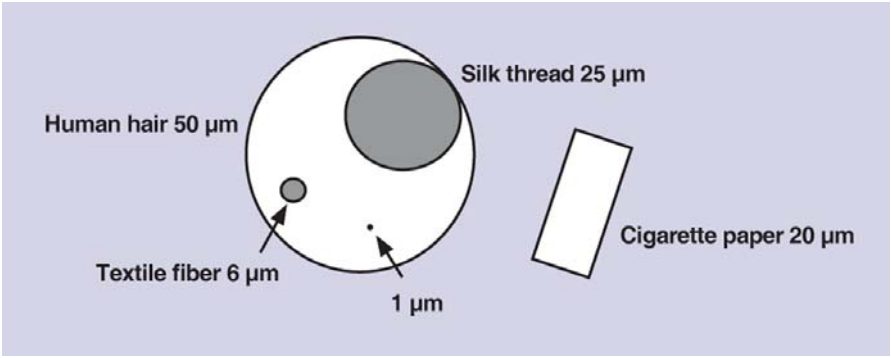
- **And what growth rates does Heidelberg hope to achieve during this period?**

We're aiming for average growth of 5 percent a year. With our innovative strength in hardware, software and brainware, there's no doubt we'll succeed.

# Sixfold precision

Printing is a highly complex process

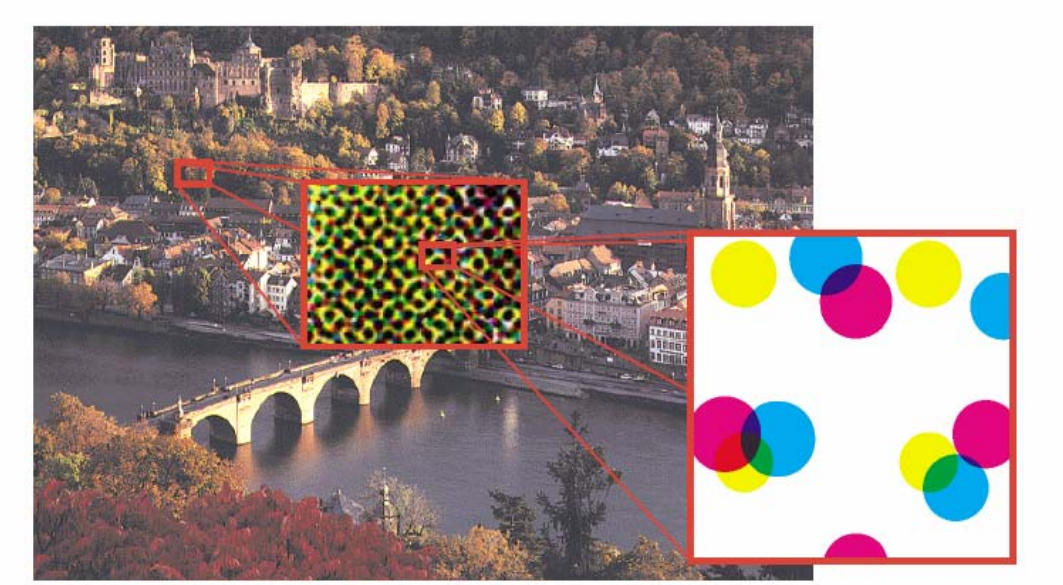
A cutting-edge Heidelberg press consists of 50,000 to 100,000 components and sophisticated software for controlling up to 500 individual drive axes and up to 300 pneumatic parts. All these elements have to be precisely attuned to one another to ensure smooth integration. This level of precision ensures high-quality printing.



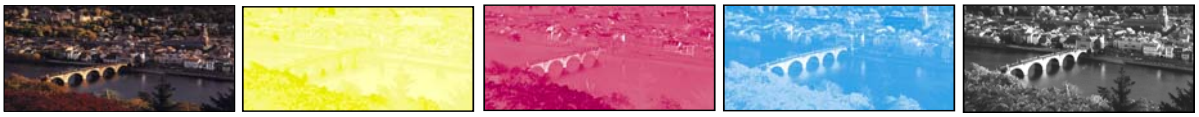

Heidelberg engineers measure the precision of their work using a unit of measurement that is roughly one fiftieth the breadth of hair. Compliance with tolerances down to one thousandth of a millimeter is essential for perfect functioning of presses, which have to process ultra-thin paper or board. In these dimensions, a human hair appears like a tree trunk with an impressive diameter of 50 thousandths of a millimeter.

In other words, 50 tons of cast iron have to work with the precision of a Swiss timepiece. The stability requirements made of the press's foundations, rollers, side frames and cylinders, which apply a tiny dot on the paper at breathtaking speed, are enormous. This high precision is required over the entire length of the sheetfed offset press, which can be anything from three meters up to more than fifteen meters – and this at a speed of 15,000 or 18,000 sheets an hour.

The need for such a high level of precision stems from the basic principle of offset printing. Color image dots, barely perceptible to the human eye, are positioned on top of and alongside each other in accordance with a precise pattern in order to create an overall image in the eye of the beholder. The individual dots become visible when the image is enlarged:



In offset printing, the same print image is duplicated almost as often as required from a flat printing plate which usually consists of coated aluminum and now increasingly of plastic. In sheetfed offset printing, unlike web offset, cut sheets of paper in different formats and grades are printed.



Offset typically uses the process colors cyan (blue), yellow and magenta (red). The combination of these three process colors, together with black, cover almost all the color nuances perceptible to the human eye. Contones are created when images are broken down into tiny screen dots which are applied either small and large and in the required quantity to the surface. In addition to this, there are “house” or “special” colors, which are specially blended tones such as the purple used on the wrappers of Milka chocolate bars, the green used by BP, the blue used by Nivea and the special Heidelberg Blue.

Process colors are applied one after the other in the offset press. A printing unit and a printing plate are required for each color. This plate contains the print image made up of minuscule ink-accepting elements.

In the printing process, the top sheet of paper in the pile is taken up by vacuum and transported to the printing cylinder using grippers. While the paper is being passed on, the inking rollers travel across the printing plate. The ink-accepting elements pick up the ink and transfer it to the blanket cylinder, which prints it onto the paper. The sheet is then passed on to the next printing unit, where the next printing plate applies ink to the paper. When the run is over, the sheet is coated, powdered, decelerated and delivered precisely onto a pile.

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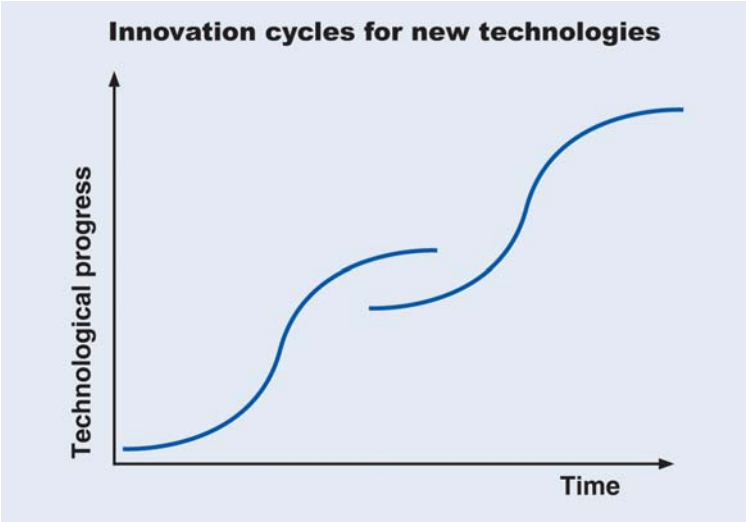
# The S curve of progress

The construction of sheetfed offset printing systems involves more than just bringing multiple technological disciplines together

Research and development depends on market requirements, customer needs and technical innovations. Heidelberg chooses its research and development projects on the basis of detailed market surveys, discussions with customers, and cooperations with universities, research institutes and partner companies worldwide. The objective is application-oriented throughout. The aim is to further increase customer benefit by introducing large and small innovations.

The Product Council is the most senior Heidelberg committee and together with the Management Board for Engineering and Manufacturing, the heads of research and development, product management, production, service and controlling, it assumes responsibility for ensuring the project targets are met. The make-up of this team remains the same throughout all the project management or quality meetings that are regularly held to discuss the latest issues and the various projects.

All technical innovations share the same aim, i.e. to save time and costs – by means of shorter makeready times, lower ink consumption, improved usability, enhanced functionality, less wastage, better quality control, and faster throughput times of jobs through to delivery to the printshop customers. A reduction of five minutes in the makeready time for a print job can add up to have a significant influence on a company's competitiveness.

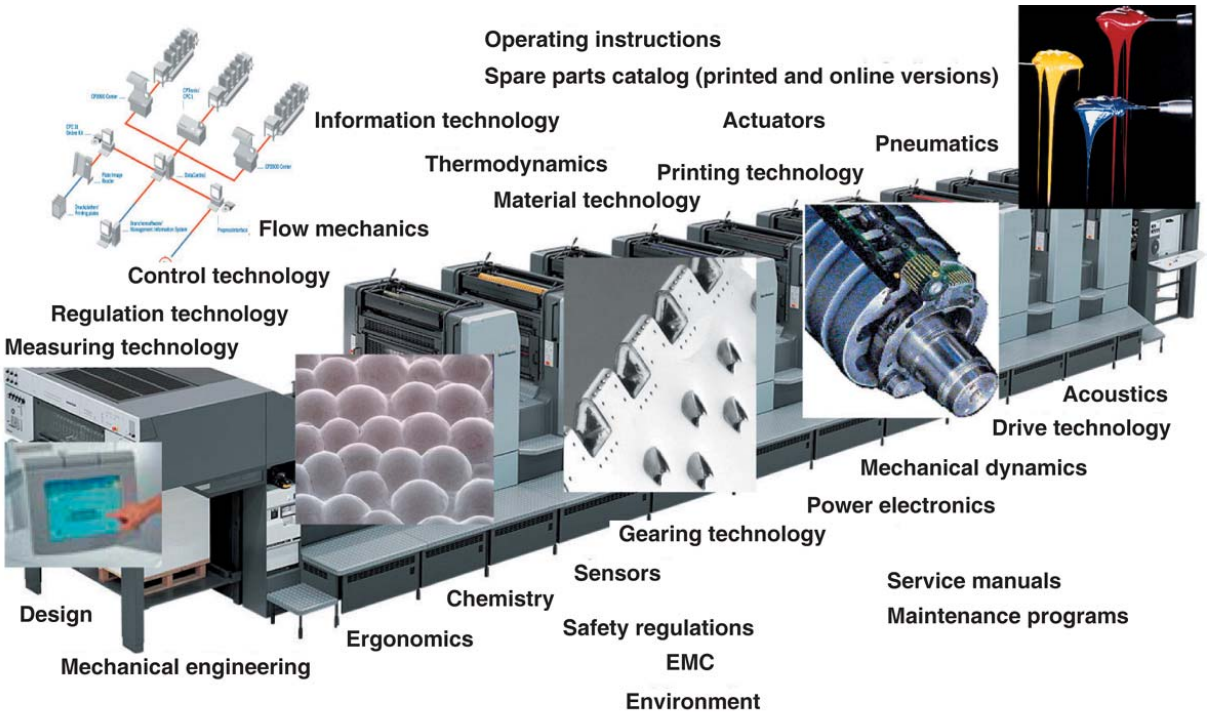



The technology change takes the form of an S-curve. When a new basis technology is developed, productivity at first only increases slowly. When the underlying principles of the new technology is grasped and experience gained of its practical application, the productivity curve increases rapidly, before flattening out when the technology has been developed to maturity.

Only the introduction of a new technology can bring about a significant upturn. However, this upturn does not start at the peak of the previous curve, but further down. One of the key roles of innovation management is to nurture new technologies that promise crucial development potential.

**A catalog of core areas of expertise**

Press construction involves more than just bringing multiple technological disciplines together. These disciplines and core areas of expertise include thermodynamics, acoustics, actuators, material technology, printing technology, sensors, power electronics, machine dynamics, design, ergonomics, gearing technology, information technology, flow mechanics, product reliability, environmental protection and electromagnetic compatibility. The development team must have in-depth understanding of how mechanical, process engineering, electronic, material-specific and physicochemical elements interact, the aerodynamics of sheet transportation, electronic control technology, and not least the complex mechanics and their many drive elements. The results are documented as an aid to Heidelberg service personnel, production and procurement logistics departments and to create operating instructions for customers.



# People as a success factor in research and development

## Training Heidelberg staff safeguards the future success of the technology group

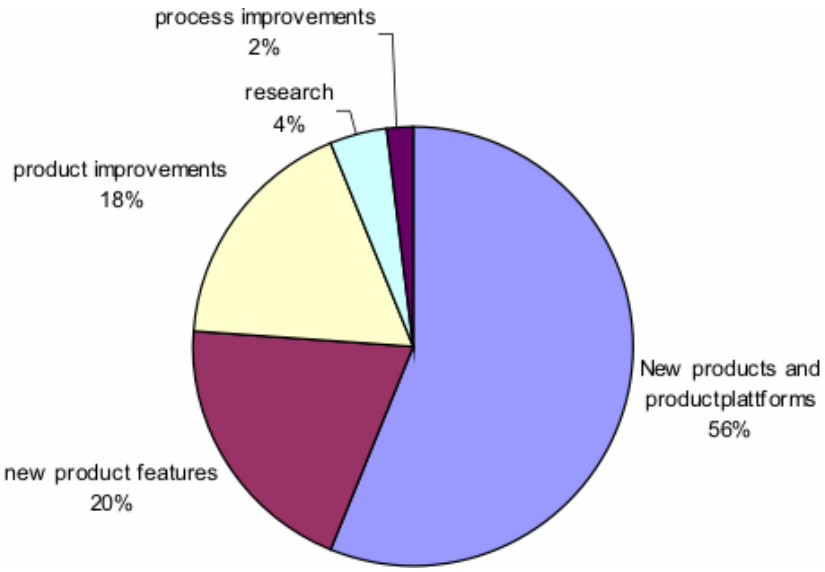
Heidelberg constructs high-precision quality presses in series. Series production allows Heidelberg to play its trump card – an extensive vertical depth of production and development that allows the researchers, developers, engineers, assembly personnel and service specialists to create unique selling points from their areas of expertise.

Curiosity, creativity and courage combined with specialist knowledge and experience creates a hotbed of invention. More than 1,400 Heidelberg employees work in research and development to create the products and solutions of tomorrow. The quality of this work stands and falls with the quality of training given to R&D staff, 50 percent of whom hold a graduate qualification from a university or college. Indeed, almost 30 percent of the engineers hold a second qualification gained by attending additional training and study courses. A degree in engineering provides a basis for understanding the complex products and their interaction in the print media industry. We could no more do without them than we could without the highly qualified printers and skilled personnel who contribute their detailed knowledge of printing and practical experience to our applications.

Heidelberger Druckmaschinen AG's research and development centers are located in Heidelberg (where the focus is on sheetfed), at the former Linotype-Hell AG site in Kiel (where the focus is on prepress and software) and at the postpress sites in Ludwigsburg, Leipzig and Mönchengladbach. In total, Heidelberg employs a staff of more than 1,400 in research and development, which makes up around eight percent of the total workforce.

| R&D staff | | Core areas of expertise |
|---|---|---|
| Heidelberg | 1,000 | Presses: Mechanics, electronics, software, automation, engineering, aerodynamics, color management |
| Kiel | 250 | Workflow, prepress: Software, optics, electronics |
| Ludwigsburg | 70 | Folders, deliveries: Mechanics, electronics, software |
| Mönchengladbach | 50 | Diecutters, embossing machines: Mechanics, electronics, software |
| Leipzig | 55 | Saddlestitchers, perfect binders, thread sealers: Mechanics, electronics, software |

Research and development closely monitors the market, technology and competitors to develop innovative product ideas. But R&D is also closely aligned with production and service. After all, the products that are developed have to be produced effectively in series, operate smoothly at the customer's, and be serviceable by the service engineers.




*Tasks of research and development at Heidelberg*

To identify and harness innovation potential, Heidelberg has a whole range of research partnerships. To extend and further develop its core areas of expertise, the company works closely with external research institutes and universities. On top of this, students and trainees contribute innovative technical know-how to the development operations. To ensure the compatibility of our interfaces, we are involved in an intensive exchange of information and experience with industrial partners in e.g. the software industry, such as Adobe, SAP and Microsoft.

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## Patents protect our success

Heidelberg protects its position as the technology leader by means of a comprehensive system of patent management. The patent division's activities range from industrial property rights to patents, utility and design patents, and brands and domains. These rights are fundamentally important to a company's business success.

The group's worldwide patent activities are performed centrally in Heidelberg. Early and comprehensive patent applications for inventions contained in the company's own new products, and the examination of competitors' property rights are key aspects of our patent activities.

In financial year 2005/06, Heidelberg applied for patents for 153 new inventions in sheetfed offset, prepress, postpress, workflow and flexographic printing and paid out a total of €650,000 in invention bonuses to its staff. With a total of over 5,000 active applications and patents in these fields worldwide, Heidelberg leads the way in the industry.

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# Allowing room for creativity between milestones and checklists

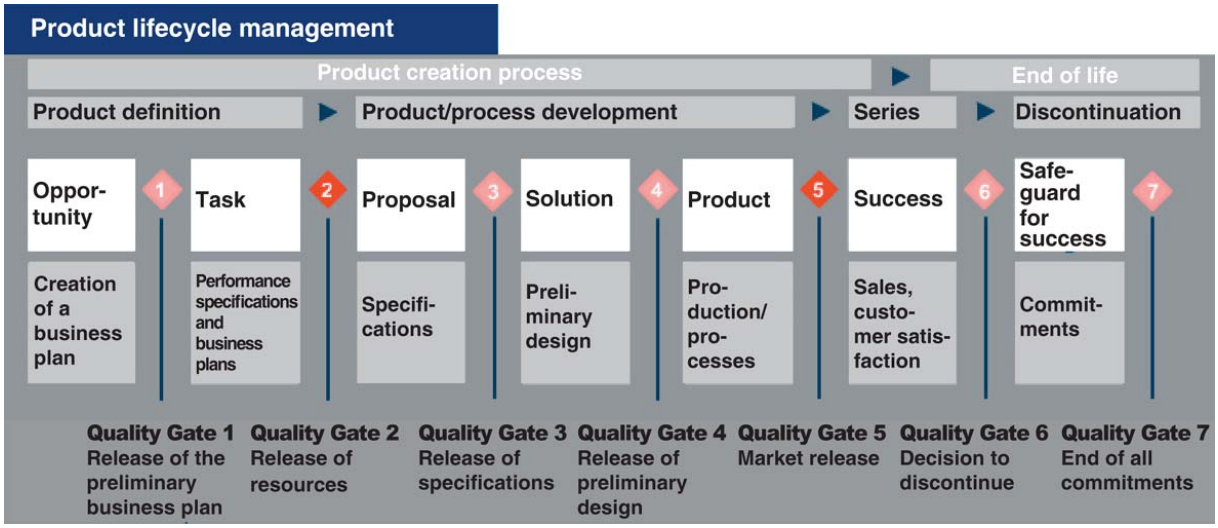
Product life cycle management provides a roadmap for innovation and helps to reveal the most efficient use of development resources

All products, from toasters to power stations and automobiles to printing presses, result from human activity and are subject to an ageing process. The products are designed and developed to meet particular needs using the available resources and, if their design is successful, they are manufactured in specific quantities. At some point or other, however, series production is discontinued. The toaster, power station, automobile or printing press are no longer constructed because technology has moved on or because requirements have changed. In other words, products have a life cycle.

To ensure business success continues after the end of the life cycle, a follow-up product is required that is better, faster and cheaper than its predecessor and the peer products on the market. Product life cycles are becoming shorter and shorter, and cost and competitive pressures are increasing. Businesses that want growth have to react quicker and more directly to changing customer requirements than their market competitors. They have to identify opportunities at the right time and quickly market new, high-value products with a high customer benefit while ensuring that they have the required maturity and quality.

**Channeling innovative strength**

Maximizing the effectiveness of resources, cutting out wastage and minimizing risks even during discussion of the initial idea are the key pillars of product life cycle management (PLM) at Heidelberg. The aim is to create an effective balance between innovative freedom and reliable processes – a documented process that covers all the major stages of the product life cycle, ranging from the product idea and business plan to the finished product and discontinuation of production. This approach increases security at each stage and increases the quality both of the product and of deadline and results forecasts. However, strictly defined processes are often the natural enemy of creativity and innovation.




To support the PLM process, Heidelberg launched a system of Quality Gates (see diagram) in 1998, which are now firmly anchored in quality-critical areas, such as development, production, service, purchasing, order management and marketing. Quality Gates are specific milestones that a product passes through during its life cycle to allow its maturity to be evaluated – from the initial idea for the product to its discontinuation. They comprise mandatory processes, targets and checklists for products with long and short life cycles. For example, presses remain on the market for 20 years or longer, prepress devices for around 5 years, and software components for even fewer.

The performance specification provides a detailed description of the market requirements of a product. They define the task to be solved. The requirements specification translates the requirements of the performance specifications into technical solutions. It describes how a requirement is to be met. The requirements specification is augmented by risk analyses, risk minimization measures, product and project costs, an analysis of the technical status and delivery agreements. The requirements specified in the requirements specification are turned into technical solutions by the development and design teams and their functions are subjected to intensive testing. When the design has been approved, the first machines are assembled and tested in operation.

## Money and market

Of the six Quality Gates, Quality Gates 2 to 5 each have special features. In Quality Gate 2, a decision is reached about approval of the resources for product development. At this point, the plausibility of the underlying business model is examined. If the market requirements have been analyzed adequately, the performance specification gives a clear picture of the task and determines the balance between current and future customer requirements and the long-term scope for technical innovation. Even at this early stage, Heidelberg collaborates closely with customers to ensure that it is meeting market requirements. Regular meetings with groups of international customers are a key control instrument for determining market requirements.

In Quality Gate 3, the practicability of the performance specification requirements and the product costs associated with the technical solution are confirmed. After Quality Gate 4, production is prepared and the necessary investment is made. The eventual market release is decided by Quality Gate 5. The aim here is to check whether the product meets the requirements set by management and the project team, for example that the production conditions are stable, that field tests have been positive, that the customer support measures meet customer requirements, that the supply of spare parts is guaranteed and that the sales team is capable of offering the product and able to support its market launch. The Management Board is directly involved at this milestone too.

Following successful series production, if further production is no longer economically viable at the end of a product's life, the necessary Quality Gates are also available for this scenario. Production of the series will be discontinued. More powerful successor products will then be launched.

**Intelligent tools**

The PLM process is supported by a wide range of tools – in the product creation process, above all through the use of computer-aided design (3D CAD) instruments. These chiefly include 3D models, integrated static and dynamic calculation tools and rapid prototyping.

The 3D view enables full visualization of e.g. presses, modules and individual components. This enables possible conflicts in the development and design process to be identified quickly. The developers share a single system landscape and can therefore consult one another and coordinate their activities – by cooperating virtually in a simultaneous engineering team or by sitting next to one another at a monitor. Soon, development will be able to construct new products in full using virtual, 3D aids.

Development creates the basic data for production and service to build upon at a later stage of the development phase. During the product life cycle, data is exchanged continuously between production, sales, service and spare parts supply. Service engineers in the field document their deployment. The customer feedback they receive is recorded using a PDA (portable digital assistant), assessed by developers, and fed back into the product.

**Most innovations come from "breaking the rules"**

The PLM process at Heidelberg is only as good as the staff that initiates, drives and manages it. After all, if processes are defined in this way, there is always a risk of introducing bureaucracy which, when taken to extremes, places too great an emphasis on adherence to process criteria and fails to leave sufficient scope for staff to think creatively. It is important not to lose sight of the fact that "more often than not, the best ideas come from lateral thinking and breaking the rules." And without ideas, there would be no PLM.

With this in mind, alongside the PLM process described above, Heidelberg developers are also given sufficient scope for creativity and open-ended research. PLM is a means of chan-

neling creativity and translating it into market-ready products. But it is also a means of drawing a line under development at an early stage when it is clear that an idea has no potential to be competitive on the market, or when the relevant technologies are not yet available or cannot meet the specified requirements at a reasonable cost. When this is the case, it makes sense to suspend or postpone projects that are counterproductive and which simply represent a waste of resources.

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# Organizing modules and interfaces

Development guidelines at Heidelberg – coordinating the work of many specialists and thousands of components

A sheetfed offset press is made up of many tens of thousands of individual parts that have to interact more precisely than a timepiece. Developing or enhancing a machine of this kind is a complex project.

The project schedule also makes clear why research and development, production, service and product management are represented in the project teams from the outset. At each stage of the project, it is essential to have smooth interaction between all functions in the company in order to save time.

The requirements for the new project have to be defined before the project starts. As well as product management, development also plays a significant role at this stage because this is when market developments, technical innovations and customer requirements are brought together. At this stage, specialist committees carry out intensive analysis to determine the required properties of the next generation of presses. These are all recorded in the performance specification. The next step is largely managed by development. It devises solutions for the required properties and creates a press concept, e.g. for a press in the 105 format class (74 x 105 cm) that can output 18,000 prints per hour. A number of trials are conducted to determine if and how particular technologies in crucial areas of the press meet the required specifications. Even at the design stage, production – which covers manufacture and assembly – is involved. Regular discussions are held with the assembly and service teams.

A wide range of disciplines and departments provide components from their “assembly box” as a means of technical support. The number of specialists working on their components and exchanging information is often in the region of 100, sometimes more, sometimes less. To optimize the project time available, many areas work simultaneously on a solution for a particular problem. All the components required have to be described precisely beforehand, to ensure that they meet their specifications.

Perhaps some parts and assemblies from predecessor presses or other new developments can be used. Some have to be designed from scratch because of the increased performance

expectations for the press or because new, better technologies are available. Purchased components that meet Heidelberg's quality demands and which have undergone tests to verify that they meet the special requirements in the press environment can also be used. Many of the parts and assemblies are produced and assembled in-house. The deadlines for part deliveries have to be synchronized and monitored with a high degree of accuracy.

## Time is at a premium

While the actual press is being developed, the software and control modules also have to be adapted to the new demands and attuned to the press, because a press can only work properly when there is smooth interplay between mechanics, software and control technology. To guarantee this, simulations, trials and service life tests have to be carried out.

After approximately a year – depending on whether final trials are still underway – the new press enters the construction phase. Production and purchasing are involved in the discussions at an early stage. The specialists for casting and large part production in Heidelberg's own foundry in Amstetten begin their work, followed by the production planning and assembly planning production departments. It is essential that they all commence their production preparations on time. While development is busy creating test parts for constructing the prototypes, production is already procuring the operating equipment required for series production and assembly.

Several months have now passed since the project kicked off. The plan is approved. The test team that is affiliated to the development department builds the first functional prototype of the new press. At the same time, work starts on creating the press documentation – which consists of an operating manual, a spare parts catalog and a service manual. The next step is to construct and procure service tools and to train the trainers and fitters in the Heidelberger service organization.

The functional prototype is subjected to intensive testing, test prints are made, and the construction is optimized. This process often goes through several iteration and optimization loops until all issues have been resolved and all technical problems and faults have been identified and rectified.

As soon as development has commissioned the functional prototype press, product management begins to select suitable field test customers. Purchasing and production determine the requirements for part procurement and series assembly. Simultaneously, development carries out printing and system tests to qualify the many new components and assemblies. Next, the press undergoes an "internal practical test". This means that print jobs received from customers are printed on the functional prototype press on an experimental basis under practical conditions. When this has been completed successfully, the press is ready for a field test. This test is supported by product management, development and service, who use empirical insights and customer feedback to further enhance the new product before it enters series production. Product management then creates the documentation required for the new product so that it can be used by other areas in the sales organization.

When the functional prototype has been qualified successfully in the field, development has

met all the necessary release requirements, and all the preparations have been made for series production, the new product is “released onto the market”. That means it is now offered for sale. Series production and assembly begins. At this point, project managers and experts from development sometimes join the assembly and service teams to contribute their know-how to series assembly operations.

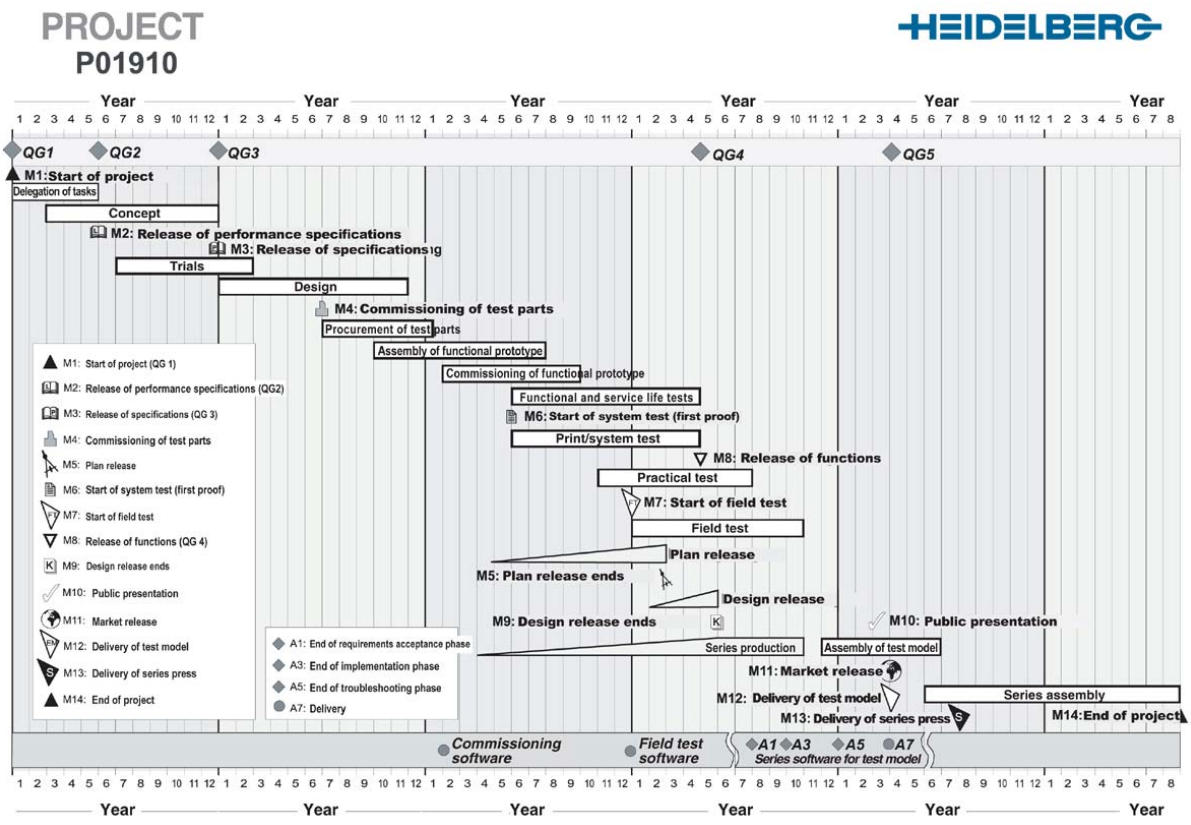
## All disciplines under one roof

There can be no question that coordinating such a complex division of labor requires precise planning and documentation and close cooperation across departmental lines. To enable this, Heidelberg created development guidelines. They provide the necessary structure for the development projects and ensure that projects remain on course. After all, if a project begins to stray off course, there is a risk that valuable resources will be squandered.

In principle, all areas of the company involved in the project – marketing, product management, mechanical development, control and software development, production, purchasing, assembly, controlling, service, industrial design, product reliability, environmental protection, documentation and standards – are integrated. This prevents misunderstandings and ensures cross-departmental consensus about content and procedure. It also paves the way for production and assembly during system development.

Projects such as the development of a new printing press take a number of years. High demands are made of the project manager, the project team and all the parties involved. The project manager organizes the project and represents it externally. He reports to the steering committee, which is a kind of consulting and control body. The steering committee normally consists of managers from development, product management, service, assembly and controlling who are also responsible for the product line in question. Regular milestone meetings are held to discuss development progress and budget planning.

With so many simultaneous and networked projects, it is essential to be able to react flexibly to resource deficits and project results. Priorities, resource requirements and team members change during different stages of the project. Depending on the size of the project, subproject managers are also appointed, often from assembly, service and product management.




The project schedule defines various activities and milestones that have to be completed by the end of the project.

- Project start (appointment of project manager and project team)
- Assignment of tasks and creation of performance specification
- Formulation of a concept describing the technical solutions for the requirements set out in the performance specification and how they are implemented
- At the same time, trials are used to clarify the feasibility of the performance specification with the chosen developments and the applicability of new technologies
- Design of the press using 3D CAD
- Test parts are procured and one or more functional prototypes are built for the above-mentioned tests and qualifications
- The functional prototype press is commissioned
- Functional and service life tests are used to prove the fulfillment of the required functions in the performance specification and the durability of the components
- Print test, system test to check the complete press
- Practical test run of the complete press in house (jobs are printed under operational conditions)
- Field test at selected customers; corrections resulting from feedback are made to the new product before series production is approved
- Production preparation release
- Production release: The planning team for series production plans the operating resources required for production and assembly and draws up assembly plans. It releases its processes. The actual production process begins.

- Release of parts lists in development
- Series production: The parts are produced and procured
- Market release: The market organization starts sales of the new press.
- The first presses are produced under series conditions, i.e. test model assembly begins
- Delivery of the first test models
- Series assembly immediately after test model assembly
- Delivery of the first series press
- Defined project end. Responsibility for the product remains with R&D. Development continues to lend its support in the case of any assembly or field problems. Fixed quality circles are set up, containing team members from all the relevant areas (e.g. development, service, assembly, product management and, if required, purchasing). Quality aspects are addressed, analyzed and prioritized and then processed in the relevant area and rectified for series production.

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# Teamwork with outstanding networking

The matrix organization of R&D at Heidelberg creates product responsibility and uses expertise to the full

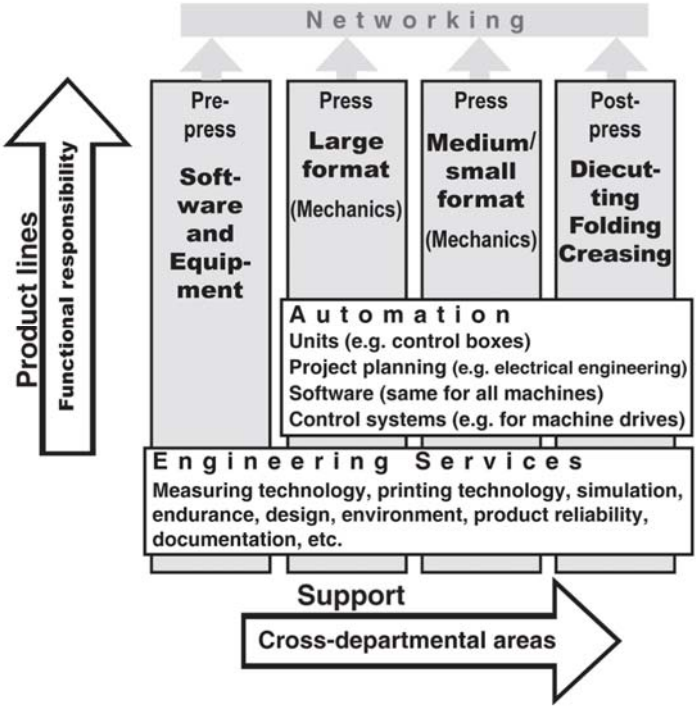
The various cogs interlink smoothly and the entire process is networked. The effects of designing a new, more powerful and enhanced press extend down to the tiniest details of the entire development process. Say, for example, a new main drive, extra subsidiary drives and more powerful servo-drives are required. The relevant development section is charged with selecting and qualifying the required drives. The press has to be wired, so a suitable cable harness is included in the planning. Or perhaps the new press requires more air than the previous model. Can any of the units in house produce 500 liters of air per minute or will these have to be purchased from a supplier?

The press has a modified washup program. When the user presses button A on the touch screen, the plate cylinder is switched off and the washup device is set in motion. A developer from the press-related software team modifies the software code, taking into account the effects of the modifications on the existing press series. Now drive 5 in printing unit 5 moves left to point Y at 3 revolutions per second.

How is it possible to manage the further development of such complex, interlinked systems and how can the researchers and developers be deployed most effectively in the various projects?

The Heidelberg portfolio covers everything in hardware and software for prepress, press, finishing and process chain integration. A matrix-based method of organization ensures that responsibilities for product lines are clearly defined and that expertise is deployed and further developed in the optimal manner.

## R&D at Heidelberg: Matrix organisation




The product lines (see diagram) show the types of press in a particular format class. The large format sector includes presses in the 70 x 100 cm format class and higher, such as the Speedmaster CD 102 or the Speedmaster XL 105. The small- and midsize format sector includes the Speedmaster 52 and 74 and the Printmaster presses. These sectors do not include the prepress areas, prepress software, platesetters or finishing using trimming, diecutting, perforating, folding, creasing, binding, stitching or scoring machines. All these areas are integrated in Heidelberg's Prinect workflow system.

The team in charge of a particular press format or product line is responsible for ensuring that the product is fully functional, and determines which projects are implemented in the product line. However, there is a regular exchange of information between the product lines. Cross-departmental teams provide support for all projects and development activities to ensure that solutions can be used across product lines, thereby guaranteeing efficiency and creating synergies.

The staff in most of the cross-departmental teams process cross-product-line and cross-site tasks such as calculation, simulation, measuring technology and product design (industrial design). Test logistics, service life tests etc. are often incorporated into several projects at the same time.

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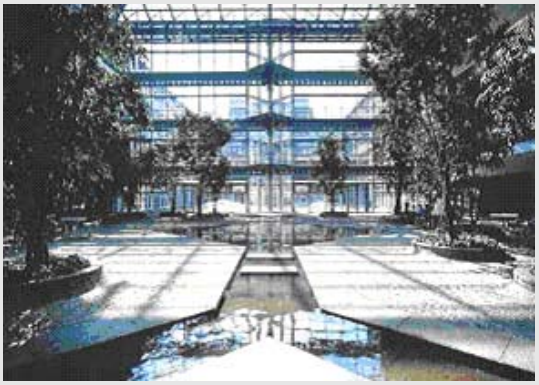
# A symbol of open communication

The research and development center in Heidelberg



The communication center is a modern, open-plan arena filled with cutting-edge technical equipment and space for working and creative thinking for close to 800 employees. After a 2-year construction period, the Heidelberger Druckmaschinen AG research and development center was opened in April 1990. The building, which is bathed in light, has floor space of over 70,500 m² spread across 4 floors, and contains offices, an archive, meeting rooms, and modern training and conference rooms.

The nerve center of the building is the 3,000 m² test hall, which is hidden from view in the basement of the building. The center of the hall houses a roofed interior courtyard, which provides a communications junction for mechanical and electronic engineers, researchers and test engineers, patent and standards specialists. The relaxed atmosphere and greenery is designed to foster communication between the different areas. To shorten the distances that personnel need to travel, walkways were constructed on all floors between the wings of the building. Access to the research and development center (or FEZ as it is known locally) is only possible with a security pass to prevent confidential information from this hub of innovation reaching unauthorized persons.

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# Combining, experimenting, thinking ahead of their time

Hot on the trail of new ideas – the predevelopment team sniffs out the technologies of tomorrow

Is it possible to jet-spray ink in the printing unit to enable more precise metering? Can conventional printing inks be dried quickly using laser beams to make the prints ready for finishing immediately? The developers and production specialists at Heidelberg always have their sights trained on original ideas, unique solutions, and new technologies in other sectors that might offer potential in offset printing.

Tight deadlines are set for the mechanical and electronic development cycles in the operational development areas working on developing specific products. Projects and methods that do not comply with this timeline run the risk of being terminated.

The process of testing and realizing new technologies is protracted and not always straightforward. For this reason, a separate predevelopment department was set up in 1995. Its task was to systematically find, identify and develop innovative solutions and technologies for new products. The focus is not on developing a series-ready product, but on proofing the concept. In other words, on making the new technology understood and ready for the start of product development, i.e. ensuring that there are basically no “knock-out” criteria for the technology.

The 25-30 employees in predevelopment have to think many years in advance rather than just many months. Some of the projects they work on only enter series production a decade after the original idea. The work demands a scientific approach and the ability to translate ideas into practical test statuses, installations and test parts. No less important is the ability to carry out in-depth, worldwide research on the Internet and in databases, specialist information sources and research publications.

## Finding your way around a forest without a compass and a map

Job satisfaction is high among employees. They have creative freedom – though this should not be confused with an easy going approach. The job of the predeveloper is to find a pathway capable of being turned into a busy highway. What they face is a forest without a map or a compass. Often, they unexpectedly stumble across canyons or mountains that set their journey back months. The challenge is enormous. After all, their work ultimately has to lead to the creation of a new product.

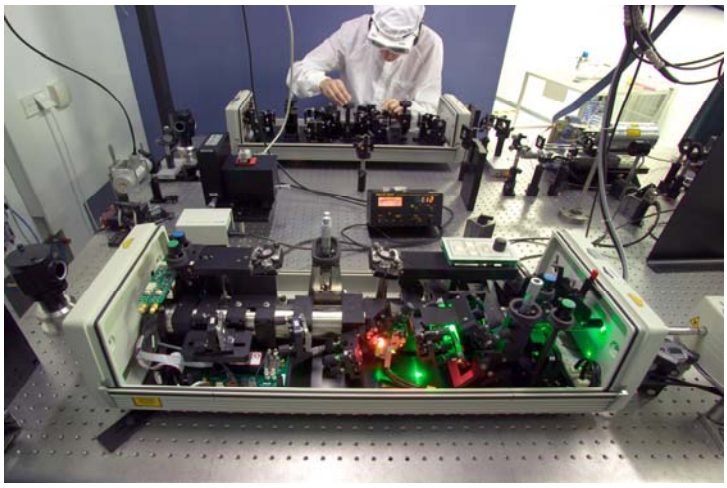
Teamwork is crucial. Predevelopers work on several projects at the same time. Each one has to keep up to date with all the projects in predevelopment. They have to be flexible and open to ideas, criticism and suggestions.

There is a high risk that a good idea may fail to result in a project. According to empirical values in the industry, 80 percent of ideas are confined to the wastepaper bin. Predevelopment staff must be extremely patient and cannot afford to give up the ghost even after several failed attempts. The team is certainly highly qualified. The 20 academics in the predevelopment team cover all disciplines – mechanical engineers, process engineers, electronic engineers, control technology engineers, precision mechanics engineers, chemists and physicists. In addition, the team is supported by experienced technicians, trainees and students.

### What does the market want?

By working together with the Heidelberg sales team, product management and consulting customers, the team gets an idea of future trends in the market. The goal of predevelopment is clear – to develop technologies that enhance the offset printing process and offset printing presses, to extend technological horizons, to develop new materials for practical applications, and to assess the potential of alternative technologies by means of experiments. And, whenever possible, to create unique selling points for Heidelberg.

Predevelopment has its own electronics laboratory for carrying out fundamental research, a color lab, a mechanics lab, a physics lab and clean room laser lab, not to mention a test area in which complete presses can be assembled for testing.



*The fundamental development work at Heidelberg is performed by scientists and engineers working together in an interdisciplinary environment, as here in the laser lab.*

In many projects, predevelopment works together with universities and research institutes worldwide. Its partners include Heidelberg colleagues from operational development areas, the production development department in Wiesloch and the series production department. Employees in the operational areas only begin to acquaint themselves with the new technologies when the results are due to be submitted to product development. Predevelopers often accompany a market-ready project into development or production when the predevelopment work has been concluded. This leads to a changeover of staff, but ensures a supply of fresh ideas to predevelopment and the other departments. In addition, a lot of the knowledge accumulated here is then passed on to development and/or series production.

However, predevelopment projects do not simply look after themselves. They are also subject to project management and a defined set of goals and milestones. These projects are controlled by management teams, sometimes even directly by company management. These management teams also decide whether a predevelopment project is passed on to product development. For this to happen, the basic questions must have been underpinned by experiments and the result must be reproducible. Ultimately, the cost-benefit analysis must add up. If not, the project is written off as “not technically feasible under current conditions”. It takes courage to terminate a project. Sometimes, projects are put on the backburner until a new idea suddenly appears or a technology is available on the market and a viable opportunity comes to light.

## Market success through innovations – the Suprasetter laser head

*It is vital for a technology company that caters for the complete process chain in offset printing to build up its own prepress know-how. One important innovation project that began in Heidelberg predevelopment and led to market success is the laser head in the Suprasetter*

*platesetter. This semiconductor technology represents a major step forward and testifies to the innovational prowess of a company that previously specialized solely in press manufacture.*

*Only a bulky, unscalable laser head and a small laser head that could only be scaled with great difficulty had been available on the market up to that point. Spotting this gap in the market, Heidelberg began a predevelopment project to develop a compact, scaleable laser head.*

*The idea was to build and incorporate 64 lasers on a single chip. Each laser can be controlled separately and extended by additional modules. A worldwide search began for partners who could build the required optics and the optical semiconductors required to produce and conduct laser light. What know-how exists in house, e.g. in the Heidelberg software and prepress development, and what has to be procured from specialists? Visits were made to firms and institutes to determine the restrictions and problems of the technology.*

*The laboratory prototype showed that the technology worked. Product development began, and it was possible to unveil the Suprasetter in time for Drupa 2004. The product offered high resolution – even for frequency-modulated screens – outstanding scalability and a unit that could be upgraded to meet customer requirements. And what's more, it was successfully developed within a relatively short period of time.*

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# The information superhighway enters printshops

The Prinect workflow developed by the software house in Kiel integrates all processes

How is a print job processed? Firstly, the printshop costs a customer query. The job arrives. The job folder is created. The data is entered. The print job is prepared. There is consultation with the customer. Data is transferred by e-mail. The job is released. The impositioning data is entered. The imaging data is entered. The printing plates are produced. The printer is set up. Data is entered in the press. Print proofing takes place. The print sheet is monitored. The ink is adjusted. The data is entered and checked. The ink is adjusted. The production is started. Later, in finishing, the data is entered in the cutting machine. Then the process moves on to the folder. Again, data is entered. Actual costing takes place. More data is entered. How long did it take? How much paper waste was there? Was the job profitable? Well, more or less…

Many sophisticated standalone solutions were available to printshops for commercial planning and production with prepress, press and finishing, though most commonly with a "manually operated" interface. That caused repetitive work steps, greater effort in procuring and preparing information, time losses and high costs. How much effort it would save to integrate all the printshop processes with one another! This was the starting point for a large-scale software project by Heidelberg called Prinect – an abbreviation of "print" and "connect".

The task was to develop an information highway for the printshop that ensured a flow of information in all directions instead of being a one-way street. Development mostly took place in the Heidelberg software house in Kiel, involving around 200 software developers working in close cooperation with departments in Heidelberg itself. The Kiel site originally specialized in prepress under the name Linotype-Hell, which joined the Heidelberg Group in 1996 and contributed extensive know-how in color management, fonts and software development.

## One language instead of many dialects

When Prinect was first devised, the provider market was a Babel-like mish-mash of programming languages. Nothing really fitted together. The many solutions that existed for standalone stations in the printshop had evolved over time. There had been no integration along the chain. Each “area” had its own infrastructure, its own dialect and its own wavelengths that were not compatible with those of the neighboring area. The process was one of ongoing diversions, bridge-building, dead-ends or repetitions, such as entering the same job numbers again and again.

The most pressing task was to create a chain that ran smoothly. The platform for this was created with “JDF” (Job Definition Format), which is based on the standard Internet language XML. Communication between individual software components has to take place within fractions of a second, so that the overall system can be productive.

JDF replaces the many dialects with a common language. This standard language was defined by an international consortium known as the CIP4 organization, which is an independent, globally active association based in Switzerland whose goal is to integrate computer-based processes in the print media industry. Heidelberg works together with other manufacturers from the print media sector in this consortium to develop completely open interfaces. This makes it possible to exchange data between all JDF-enabled equipment. All JDF-compatible devices on the market can be integrated in the Prinect workflow and vice versa. The new standardized JDF data format provided the vehicle to get the Prinect project up and running.

The next step was to define the specifications and properties of the different software components for Heidelberg Prinect, i.e. to create a development plan for all subsections of the information highway. All parties involved in the process, that is, all of those residing on the data highway, could lodge their requirements. Which components – from the ink settings to the cutting marks – have to be managed? How are the parameters transferred?

Heidelberg unveiled the Prinect system and its core components at drupa 2000. The system uses a workflow management system to integrate printshop processes step by step – a kind of SAP system for the printshop. Prinect maps the business and production know-how of the printing industry.

## Software only understands yes or no

Software consists of lines of programming that trigger particular commands. The individual steps are processed in fractions of a second on the basis of a defined process logic. Basi-

cally, the machine only understands yes or no. In a sense, programming includes streets, diversions and traffic lights for the flow of information. When signal A appears, turn the motor to the left for three seconds. When signal B appears, turn the motor to the right for two seconds, and notify display Z. Process descriptions in the print production operation contain tens of thousands of lines of programming.

Coding requires highly trained, specialist software developers with a level of qualification similar to that of physicists or chemists. The molecular structure of workflows has to be examined – it's like using tweezers to work on the highly complicated infrastructure of a large region. The Prinect modules not only have to function in themselves but also with other modules and with the software of all connectable devices, such as platesetters, presses or finishing machines.

Coding is a task that demands creativity, logical thinking and concentration. For the software to be implemented effectively, it is absolutely essential to have a precise understanding of the processes and influencing factors – in other words, what happens when in the printshop. This is Heidelberg's core area of expertise and highlights the value of a software solution for the customer and user. Heidelberg has spent many years building up its know-how of color management, screen printing, RIPs, workflow, JDF, impositioning, and of understanding the Printready print process. And this know-how is brought to bear in practically every line of the software code.

## Specialist know-how

Software developers and other university graduates who start in Heidelberg software development normally require a year to acquire the necessary knowledge about the print process and to work through the core topics. They need the ability to think analytically, because many of the functions can only be solved with the aid of mathematics. Most of the staff in the Heidelberg Prinect software house are physicists, IT specialists and mathematicians.

For example, a formula has to be developed that distributes the image dots in such a way as to produce screens. With impositioning, the problem is combinatorial. The arrangement of the pages on the print sheet depends on the finishing process, for example the folding. 3D color spaces have to be understood mathematically – so that millions of different color nuances, created by a particular blend of red, green and blue (RGB color space) or cyan, magenta, yellow and black (CMYK color space), can be described with the aid of numbers or by the process of transforming RGB into CMYK can be forged into software using a suitable algorithm.

Lastly, Heidelberg developers must maintain close contact to major providers in their sector, such as Adobe, whose PDF format has become a standard for managing print data and which is advancing its research work in this field.

## Parallel development with a deadline

The (further) development of the various releases of the Prinect modules takes place simultaneously in the different departments in accordance with clearly defined deadlines and con-

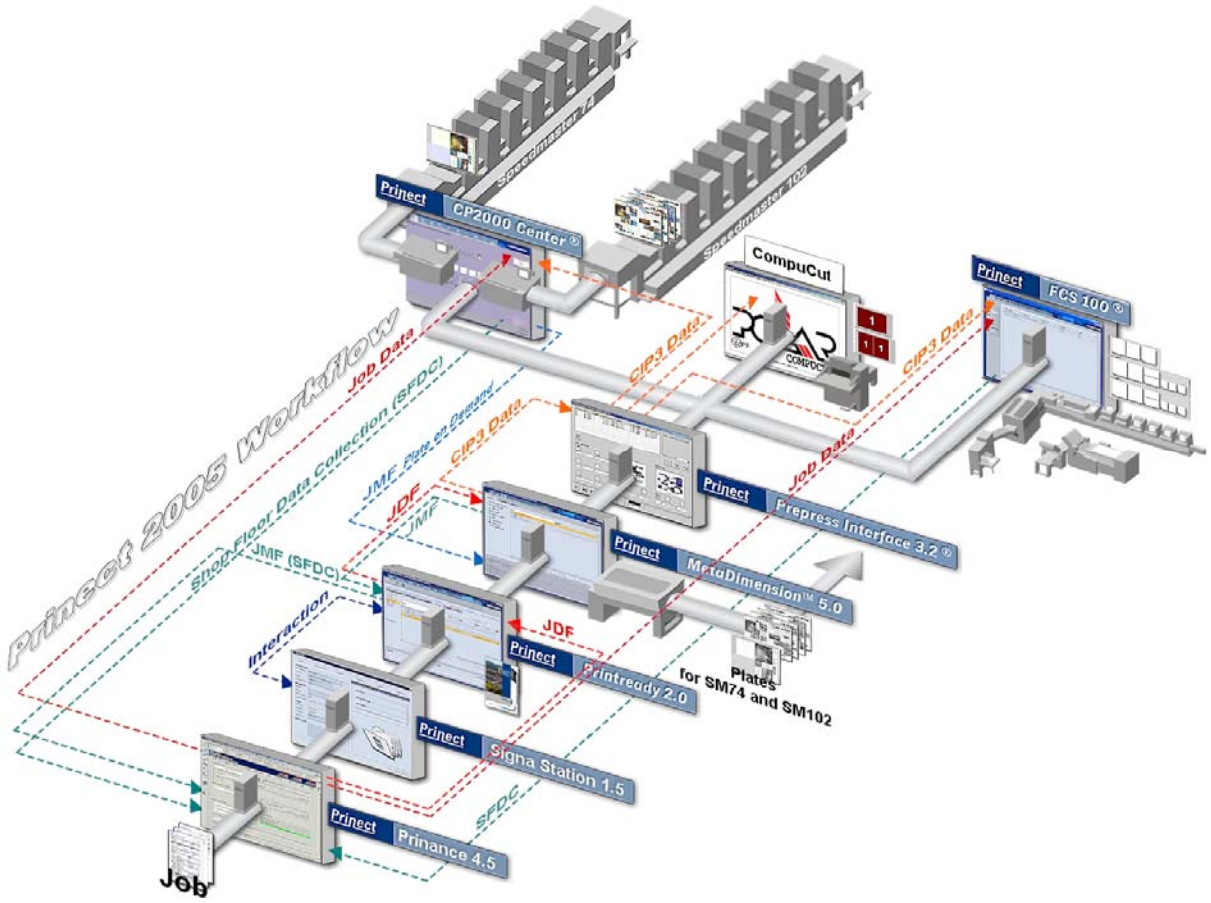
tent specifications. Printready print production architecture – RIP, Adobe, licenses and screens – applications with content management, Signa Station and software infrastructure – test and documentation – integration of machine software – in total more than 200 software developers, each of whom works on many lines of code every day that depend on other lines of code that are in the process of being changed, rewritten or tested.

Precise definition of the characteristics and interfaces is therefore essential for any development. When this has been completed, the software developers can begin to implement and integrate the system, i.e. to “plug” everything together. In figurative terms, that represents 600-800 pages of thick legal volumes jam-packed with rules and regulations.

A lengthy test program has to be run to check whether the lines of code actually fit together. Each software module is tested individually. Then tests are run to verify if this software module functions with the other modules in the particular product. Scripts are created for these tests, in which automatic test routines are called and run automatically during the night. The next morning, the developer looks at the log, identifies bugs and rectifies them. Does the software set up the job? Does it operate the RIP? Does the processor crash during trapping?

In the regular interoperability tests, which represent a kind of internal certification, a simulation is run to verify that the software interacts correctly with other products. Is job data transferred? Does this data activate the desired presettings in the press? Can a replacement plate be produced using CtP and the data in the event of a mechanical error in the printing plate? The departments have to supply their software package by the defined deadline. A development team made up of Heidelberg and Kiel employees is responsible for integration in the Prinect workflow. In the field test (beta test), the new versions are used in practical operation. All the development steps are entered in a document which is used as a basis for creating the user manual, online help documentation, service manual and instructions for the customer.

## How does Prinect work?



Overview of the Prinect workflow

The world of Heidelberg Prinect begins with PDF. The customer or the design agency sends the job data. The printshop creates the job in the Prinect Prinance module, a business management information system. The customer has remote access to the job data online right up to the start of prepress processing. When the job reaches Prinect Printready, the actual prepress production software, it has moved into the realm of JDF. In Signa Station, the pages are positioned on the print sheet in the order required by postpress equipment, e.g. the folding machine used to create the cross fold.

In Prinect MetaDimension, the data is ripped, that is to say, the image data is converted into screen dots. The Prinect Profile Toolbox software creates ICC color profiles for the color printers, proofers and presses. The proof is released. Prinect MetaShooter integrates the Computer-to-Plate technology into the workflow. Prinect Profile Toolbox adapts the printing profile. The printing plate is imaged. Prinect Prepress Interface is the interface between prepress and the steps that follow in press and postpress for presetting the ink zones, the cutting machine, the folder and the saddlestitcher.

The press can begin operation. The printer starts the job on the Prinect CP 2000 Center, the press control station equipped with ink zone control. The Auto Register module controls the register setting automatically. The press is inked up and the first OK print sheet appears.

Prinect Image Control, the high-end colorimetric system, records the print result and sends the data to the system to allow any deviations to be determined. The plates can be called up on demand. The operator in the pressroom starts production of the next batch of printing plates by pressing on the relevant entries in the list that appears on the touchscreen. Compucut uses the presetting data from the Prepress interface to generate the press data required for trimming the paper. The FSC100 module includes other data from the production and information system in the Prinect workflow. All the planning and operating statuses at the various workstations can be called up from the Data Control production management system.

**Time and cost savings**

This standardized digital workflow, which features open interfaces between all the production tools, enables time and cost savings of up to 30 and 15 percent respectively and enhanced product quality. Integration of the printshop processes ensures shorter makeready times and high press availability and therefore boosts productivity more than measures that merely increase press speed. Integrated digital production also helps the print media industry to produce shorter runs cost-efficiently using the offset method.

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**PRODUCT DEVELOPMENT**

# High-precision lasering

The Suprasetter CtP platesetter features a state-of-the-art laser head from the Heidelberg Prepress development team in Kiel

*The development and production of a laser head is an absolute first at Heidelberg. The Suprasetter laser head, a compact invention that fits in the palm of your hand, images printing plates in format classes of up to '105' (74 x 105 cm). The first of many patents for this innovation was issued in August 2004 in the U.S. The modular design of the platesetting system is unique. It can be upgraded within a few hours, therefore enabling plate throughput to be increased continually.*

*Heidelberg Prepress in Kiel, an autonomous division of the company with a development staff of around 70, was responsible for the product planning, product management, development and series support for the platesetter. The Suprasetter platesetters will be manufactured in the Wiesloch factory.*

*New CtP platesetter – the Heidelberg Suprasetter*

*Prepress development takes place in close consultation with other departments such as product management or design. Hardware development and production logistics at Heidelberg Prepress relies on a wide network of suppliers, who develop and manufacture components specifically for Heidelberg.*

*Heidelberg Prepress consults printing plate manufacturers and gathers information on new development projects to ensure that developments such as the laser head are compatible with all printing plates on the market. The plates undergo strenuous testing in the Kiel laboratory in accordance with defined parameters. Plate manufacturers also commission tests at this laboratory in order to ensure that their products gain Heidelberg Prepress certification.*

## The laser head – a new basis technology

*The corresponding Quality Gate was passed in the development process when research in the Heidelberg predevelopment department confirmed the feasibility of a scalable laser head system, and actual product development begun. Within three years, the Suprasetter platesetter had been developed into a series-ready product. As a result of the high quality of the laser beam and the precise positioning of the plate, Heidelberg increased its know-how considerably. The modular laser head is now the basis technology for the next few years.*

*The laser head developed and patented by Heidelberg fits in the palm of your hand*

*There was a long list of requirements for the Suprasetter. Heidelberg required a platesetter that would cover the 105 format class – after all, development of the new Speedmaster XL 105 was just around the corner. The machine also had to offer remote capability. The aim was for service engineers to perform remote diagnosis online. In addition, the Suprasetter was required to communicate with the Prinect workflow software. Many German, European and international occupational safety and environmental regulations had to be taken into account. Two members of staff from the prepress development department were assigned to deal mainly with issues such as susceptibility to malfunction, TÜV requirements, the Institute for Statutory Insurance and Prevention and other international institutions.*

## Streak-free image

*During laser beaming, the coated printing plate rotates on a high-precision cylinder. The laser beam aims at an extremely small spot on the plate. It generates a high level of energy density in the process. The polymer coating is heated on the beam and later removed. If the beam is not perfectly accurate, the image is blurred or streaky.*

*This system is accurate down to 1 µm (= 1 thousandth of a millimeter). 64 laser diodes had to be mounted on a 10 mm x 2 mm chip, several of which would fit side by side on a fingertip. These laser heads can be scaled in increments of 64. The laser bombardment can be pictured as a "battleships" board. Each square on the plate, with a side length of 10 µm, represents a potential target for a laser spot.*

*A printing plate in the 70x100 cm format class has 7 billion squares or potential information points. It is imaged within 60 seconds. The cylinder turns at 300 rpm or 5 meters per second past a beam, which lasers at a distance of 10 µm. On the Suprasetter 64, that equates to a shot every two to three microseconds. The Prosetter has an internal drum imagesetter that moves at 54,000 revolutions per minute. At 100 million imaging dots per second, this results in 10 nanoseconds per dot.*

*Obtaining a sharply defined print image demands precise registration on each plate. Registration is achieved using cross hairs that align the printing plates in the multicolor press, thus ensuring that the required print image can be created from the thousands of screen dots. After all, in adjusting the register, the printer wastes sheets. Registration does not permit a deviation of any more than 50 µm during printing. This precision is achieved automatically by the Suprasetter through µm–precise positioning of the plate in the unit. This position is recorded by sensors, and the plate position described accurately. The high-precision plate position meter was invented in Kiel and patented for Heidelberg.*

*To aid the development and design of the first series, several test stands and two climate chambers have been set up for conducting tests in various environments. After all, the same applies in Tokyo, Singapore and Stockholm – the platesetters have to attain the defined imaging precision and register accuracy regardless of location – whether at $17^0$ C or $30^0$ C, or with a humidity of 45% or 70%.*

**Push or pull?**

The printing plate is a “hard” interface between prepress and press. Prinect Prepress Interface is the “soft” interface and supplies the data to the press for presetting the ink zones. In the “push” workflow, the operator in prepress sends the printing data to the platesetter job by job, so that the printer who is taking the next job’s plate set to the press is always able to get plates without having to halt the press.

In the much more efficient “pull” workflow, the printer determines which plates are imaged in which order. Prinect enables a system of “plates on demand”. Prepress personnel enter the finished imaging data in the system. The operator in the pressroom can start plate production by selecting the plate to be imaged from the list on the touchscreen of the CP 2000 control panel. Status data such as the fill level of the baths or the temperature of the chemicals can be called up immediately.

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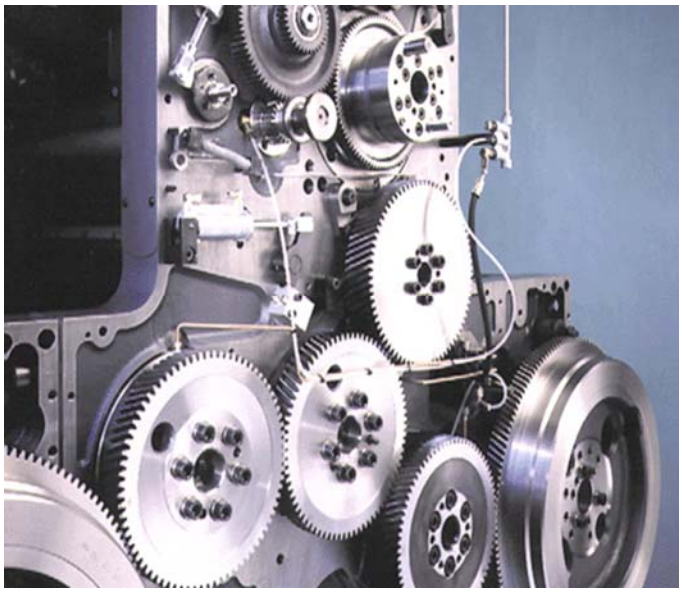
# Large-scale press project

A new generation that allows development in small, medium and large formats – the Speedmaster XL 105

A press is never fully developed, even if series manufacture continues over decades. Each of its functions is continually enhanced and refined or new features added. The latest Speedmaster is a high-tech piece of equipment that proves this point. Apart from the basic cylinder architecture of some models, it has little in common with the first models in this series, which were created 25 years ago and continue to be used successfully in printing. Development never stops. And innovation cycles are getting shorter and shorter, thanks to state-of-the-art tools, new technologies and innovative methods.



## The press must work – both in series production and at the customer's

Press development at Heidelberg is arranged into various format classes. Design mainly involves engineers, technicians and technical draftsmen. In the laboratory and testing department, mechanics, electronics engineers, technicians, fitters and printers put the press together.

Each format class is responsible for the new development, further development and market success of the product. This includes support during series production and support for problems in the field.

Approximately 10 to 20 percent of development team are devoted to ensuring that changes or enhancements required by construction are implemented smoothly in series production and thereby ensure that production can continue uninterrupted. When a component or press does not meet the performance requirements or test prints cannot be made and part manufacture or assembly is unable to rectify the problem, the skills of the designers and developers are called for.

Construction involves the creation, development, assembly, documenting and management of around 5,000 "live" parts and assemblies for each product using state-of-the-art CAD and IT programs in development. Specific systems help the constructor to utilize existing components from Heidelberg's stock of parts in new developments.

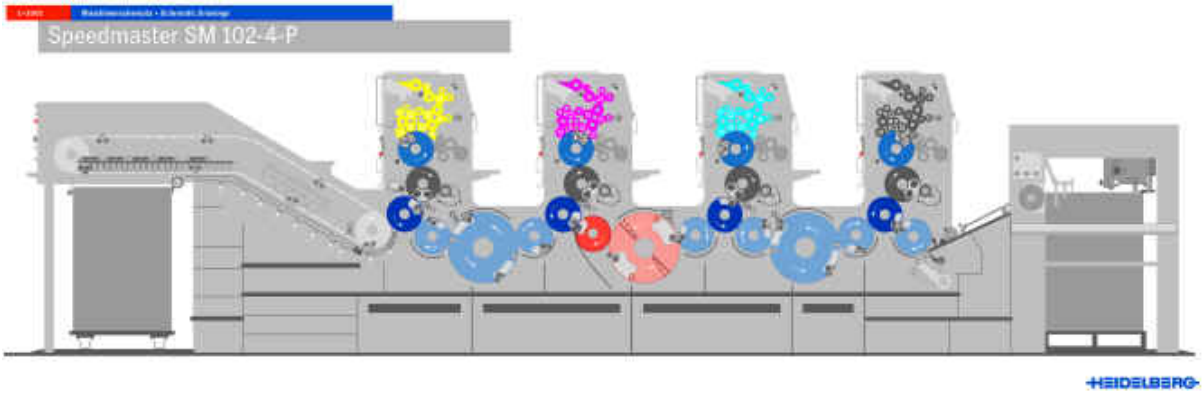
### Programmed for teamwork

In some sense, the idea of teamwork and cross-format collaboration is programmed into the electronic tools. To maximize cost-efficiency and facilitate service operations, the number of different components is kept to a minimum. The CAD system features a repeat-use function that acts as an electronic interface to all platforms and finds similarities in the requirements and geometry of parts. After all, a special screw does not have to be re-invented if a virtually identical one has already been fitted to another series. However, if there is no other option but to change parts, it is essential that supply chain management is involved in proceedings at an early stage. Experts who supply parts for the production, assembly, and service teams take the necessary steps. It is vital that the right parts are on hand at the right time and in the right area of the assembly line.

In this respect, product responsibility means system responsibility, i.e. the overall functioning of the press, covering everything from machine drives, electronics, control, software and peripherals. Product responsibility also means documenting the development results, preparing the documentation for service and assembly and creating lists of all the parts and replacement parts used. If a wear part on a customer's press is faulty, the service engineer can log on to the Heidelberg network and obtain the right replacement part from the logistics center by entering the barcode.

## How is a press developed?

What takes place inside a press? A cast-iron timepiece – bristling with electronics and consisting of cylinders, grippers, rollers, bars, rotating parts and gears – takes a sheet from the feeder pile and routes it quickly and precisely to the printing units, where it is printed with twelve or more colors. Then the sheet is turned and transferred to other printing units, which apply just the right amount of ink in the right place, before the sheet is dried, decelerated and powdered to prevent sheets from sticking together, and conveyed to the delivery pile. And all this with the utmost precision. The tiniest variations in the speed of the roller or sheet travel result in color fluctuations and inaccuracies. Research into the microprocesses involved in offset printing has not yet been exhausted to the full. For this reason, we rely on the experience of the designers and experienced practitioners.




*A Speedmaster SM 102 four-color press with perfecting device after the second printing unit; right: feeder; center: 4 printing units; left: delivery.*

When a press is designed, the first issue that has to be addressed is the format. What size is the sheet? Attention then turns to the basic press architecture. Where are the cylinders located? A 10 millimeter shift in the cylinders would bring everything out of line. The whole process would have to begin again from scratch. The arrangement of the plate and blanket cylinders would have to be clarified, as well as the cylinder gap and the diameter of the rollers. Eventually, the ergonomics of the press are checked using a wooden model. How great is the distance required between two printing units? How can convenience be maximized for the printer? The principles are put to the test in a preliminary study.

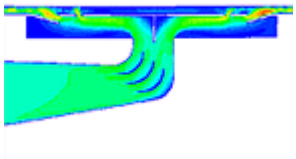
This study takes account of a wide range of factors and builds on the know-how supplied by all specialist departments: Do the components meet the requirements? What form should the tests take? Have the parts been technically certified where it matters? Do they fulfill the safety and environmental criteria? If the styling is affected – do they comply with design guidelines?

## Heidelberg know-how

The know-how that sets a press manufacturer apart from its competitors lies in the details. Heidelberg has developed core areas of expertise and unique selling points in areas such as

feeders, deliveries, grippers, perfecting, sheet travel, inking/dampening units, coating, color management, automation, operation, and workflow.

Take the example of sheet travel. The aerodynamic conditions in a press are highly complex. Paper is an extremely delicate material. The fragility of this printing stock is shown by holding a sheet of standard-sized paper at the corners and moving it towards a stream of air. Ensuring high-precision travel of a sheet eight times this size through an A1 press at a speed of 18,000 rpm or 5 sheets per second in such a way that it fits with hundredth of a millimeter precision in each printing unit, where it is printed with ink dots measured in µm, and all this while ensuring that the ink does not scrape off during turning, printing, coating or delivery and that a perfect sheet lands softly on the delivery pile – now there's an engineering challenge. There are few industries that have to deal with parameters of this kind.

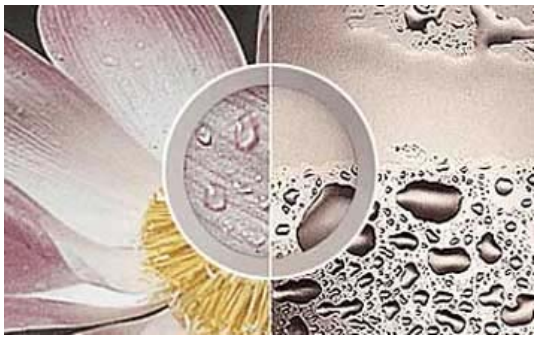


*Simulation of the air flow in the supply line of a sheet guide plate.*

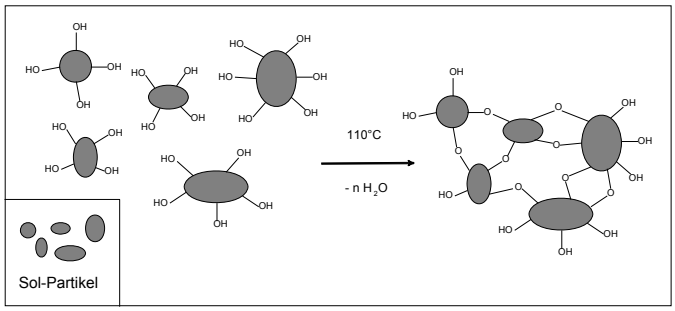
Special nozzle plates that keep the sheets at an ideal distance were developed for the delivery and perfecting unit in the Speedmaster. These sheet guide plates have been designed in such a way that air can flow through them and without using grippers they can position, stabilize and convey sheets with millimeter precision, as if on an air cushion. The correct shape of nozzle in combination with the right blower control ensures the correct "flight path" for the relevant grade of paper. In the perfecting device, for example, the air can be precisely controlled to within 0.05 millibars. This high-tech system of sheet travel enables two-sided coating of brochures, for example, without any variation in quality between the two sides of the paper.

## A Sol-Gel coating using nanotechnology ensures ink simply drips off

During transportation through the press, the freshly printed sheet may deposit ink on the transport cylinder jackets, which leads to a build-up of ink because the printed side lies face down on the cylinder surface after being reversed. These deposits may leave dirty traces on subsequent sheets. The printer may have to clean the jackets after only a few hours of operation. To minimize this effect, Heidelberg has turned to nanotechnology in an attempt to develop a special anti-stick coating.



This coating consists of tiny particles, each of which has a surface charge that repels other particles. This fine dispersal of solid particles in a liquid medium, in this case a mixture of solvent and water, is known as “sol”. The sol is applied like a coating to the chromium-plated nickel plates using a spray gun. The solvent and water evaporate, while the molecules condense to form a gel. The repelling “top” of the coating, which is a ten-thousandth of a millimeter thick, remains on the surface. As a result, less cleaning is required, resulting in a cleaner print. Heidelberg installed new production equipment especially for this innovative coating process and has been series-manufacturing the TransferJacket Plus with ‘nano layer’ at its Wiesloch site since March 2004.




## The Speedmaster XL 105 – a completely new press

*When the diameter of a cylinder is increased from 270 to 310 millimeters and the speed from 15,000 to 18,000 revolutions, the press has to be reconstructed completely from scratch. From its mechanics to its motors, side frames, gearing, inking units, sheet travel and electronics. This was the case for the new Speedmaster XL in the 105 format class, which has a net output of 18,000 sheets per hour.*

*The feeder, which features the new Heidelberg suction head, and the delivery, which features the new pile module, were designed for the Speedmaster SM 102, Speedmaster CD 102 and XL 105 with a higher-speed qualification. The system was unveiled on the ‘102’ presses in 2003 and has since been series-produced.*

*The press is protected by several light barriers or ultrasonic sensors. If double sheets or scraps of paper are identified that might damage the printing unit or blanket or detract from the print image quality, the press switches itself off.*

*The vacuum pull lay draws the sheet steadily against the side lay and ensures precise positioning. The air at the feeder and delivery can be preset, that is to say, the right quantity of air for particular jobs and grades of paper can be preset on the computer using a defined profile program. The printer can adjust the profiles to the specific requirements of the individual orders.*

### No lashing, no fluttering

*The printed sheet of paper must be delivered onto the pile precisely without lashing or fluttering. The new, modular sheet brake that controls the sheet after the last printing unit or dryer is more precise than its predecessor. Like the air setting, it can be preprogrammed. The new gripper bars were tested aerodynamically to minimize air turbulence during sheet travel. The lateral sheet joggers in the delivery reduce the movement of the delivered sheet through a combination of static and dynamic parts.*

*To ensure that the printed sheets do not stick together on the pile, powder is blown in. The Clean Star air-cleaning system collects and filters around 90% of the powder blown out of the press. The drying system has been adapted to the higher productivity. Sheet travel, air guidance in the sheet guide plates and dryer are closely attuned to one another. Wind shears are avoided. Sheet guide plates in the proximity of the drying systems are water-cooled.*

### Vibration and noise level

*When a press weighing many tons prints up to 18,000 sheets an hour, it is essential to restrict vibration. To achieve this, a system of active vibration dampers is installed. Press vibration is continuously measured during operation and actively compensated. Using an active self-correcting control device, the press automatically adapts to the pressroom environment.*

The Hycolor inking and dampening system was also developed from scratch by Heidelberg for the XL 105. Hycolor is characterized by variable inking unit configurations and extensive automated settings. It is possible to set inking unit variants or inking form rollers at the touch of a button on the press control system. The temperature of the ink fountain roller and inking unit are controlled separately and form a stable emulsion that enhances the quality of full-tone areas and shortens inking unit response times.

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# Made-to-measure machines

Competitive advantages from customized products

The highest growth rates in offset printing are being achieved by printshops in packaging and label printing and in niche applications that enable them to set themselves apart from the competition. Customers do not simply buy a press, they buy a specialist solution for a specific purpose.
Customized machines is a growing sector in the Heidelberg product range and a core area of

expertise for the world's market leader. Customizing asks quite different requirements of a developer than large series construction. A customer already exists for the press to be developed, and this customer requires a particular configuration to meet specific purposes. The separate department Customized Machines was established in the development section in 2005.

Customizing means more than just creation and improvisation. It also involves intensive application consulting for customers looking for features that will set them apart from the competition. This leads to greater customer loyalty. But often, this cooperation also brings about new ideas for customizing and provides added impetus for series development.

The jump from one-off customization to small series production is not huge. Series production starts at ten copies. For example, the CutStar sheet cutter, which cuts paper for sheetfed offset presses from a paper reel, was originally a customized project. Approximately 25 to 30 units are now constructed each year.

**Heidelberg as Project Manager**

The market requirements for customized machines come from customers and suppliers or are the result of ideas from Heidelberg. Such specialist solutions are based less on series production criteria, and more on alternative methods with a stronger emphasis on collaboration. As with peripherals, know-how for the various tasks is sought from external design agencies and development partners.

Practical development work and, to a certain extent, production are taken over by development partners. Heidelberg assigns the contract, appoints the Project Manager, provides specifications even as regards development aspects, and acquires the utilization rights for the new application. This precisely defines the process engineering, mechanical, electrical and software conditions, as well as the interfaces with existing Heidelberg systems. The partner company develops, tests and produces the required parts in close cooperation with the Heidelberg project coordinator and according to a specific timetable.

**Metal film printing using offset technology**

One example of a customizing project is the cutting-edge cold-foil technology. This technology is used to achieve vibrant, high-quality metallic effects on print products, and can be applied using an offset process to various types of printing stock with grammages of between 70 and 400 gsm. The request originated from a specialized label printer that produces high-quality coatings and a folding carton company in the high-end segment.

The advantages of cold-foil application include short makeready times (as a conventional offset printing plate is used), a printing speed unaffected by the particular technology (nowadays up to 15,000 sheets per hour), and optimal register accuracy. As a result, even fine structures and elements such as fonts, lines, and screens can be produced.

Two units are required for cold-foil application. The first applies a paste adhesive to all or part of the printing stock using a conventional offset plate, while the second incorporates the cold-

foil module with the metal foil take-up and take-off unit. The foil is fed through the printing nip between the blanket and impression cylinders. The pressure of the blanket transfers the metal layer of the foil onto those parts of the printing stock to which adhesive has been applied. When the substrate is removed, the metal layer remains on the printing stock.

The FoilStar module for the Speedmaster CD 74 and CD 102 series can apply stunning high-quality foil-based metallic finishes to all kinds of printing stock

**As well-tuned as a violin**

When the core expertise of Heidelberg is called for, customizing projects are worked on in house. Such in-house projects would be called for if, for example, a customer wanted a one-pass productivity solution for high-quality spirit labeling with various colors, spot coating, extra special colors, pearly luster, intermediary or final coating, gilding and UV matt coating. The record is currently 16 units assembled in a single press and covering a distance of more than 20 meters.

Co-workers from other Heidelberg departments are recruited to carry out necessary tests and operations, e.g. is it at all possible to have a press with 16 units? How much torque is required? Are the main drive and gears up to the job? How much lubrication and oil pressure is required? Is the software capable of covering that?

What about vibration on such a long press? A press has to be as finely tuned as a violin. After all, you know immediately when a string has not been tuned correctly. Which special units are required e.g. for the air supply or control cabinet? Do the sheets travel smoothly in this special configuration of printing and coating units? Which suppliers and development partners have to be integrated, and how (e.g. in the case of extremely long cable harnesses)? The possibilities and parameters are determined in consultation with the specialist departments and the customer.

When the decision is made to build a customized press, time to market becomes critical. In other words, some deviations are made from the customary method used in large series production in order to achieve a cost-effective solution with reasonable outlay. This process is more like the preseries steps in the development process. Many aspects are simplified. Parts

lists are trimmed down, operating instructions are not drafted in a large range of languages, parts are not offered via the traditional logistics channels, but rather ordered in the same way as test parts.

The planning board contains between 50 and 100 points, detailing who should do what, when. Series parts are used for around 95 percent of the construction. The rest is made up by converting old parts or creating new ones. There is also continuous coordination with production and service. Both departments are involved early in the process in order to familiarize themselves with the unique characteristics of the press. A special solution has to be found for the supply of spare parts and customers have to be given more intensive support.

## New inking unit technology for short runs

A rapidly emerging trend in the print media market is for ever shorter runs. Many printshops need to handle runs involving only a few hundred sheets, which brings the problem of how to satisfy these customer requirements efficiently. A digital press is cost-effective for low-volume work, but for larger-volume jobs costs are comparatively high. In offset printing there are start-up and fixed costs resulting from printing plate manufacture, setup times, and inking-up times. However, these are balanced out by rapidly sinking variable costs during the production run and the high speeds attained for runs exceeding 1,000 or 2,000. In this type of scenario, offset printing is always more cost-effective.

In a drive to increase cost-effectiveness for short runs, developers focused on makeready times and ink application. One key criterion in this work was that standard printing plates and inks should be used, so as to avoid any additional costs for materials. At Ipex 2006 Heidelberg unveiled the new inking unit technology, designed initially for the Speedmaster SM 52. The new Anicolor inking unit features ink-zone-free printing. The format-size anilox roller and inking form roller ensure that exactly the same amount of ink is supplied to the printing plate with each revolution, thus producing perfectly uniform areas of ink on the printing stock. A temperature regulation system helps to adapt ink application to the relevant printing stock over the entire printing form.

The Anicolor inking unit has far fewer rollers than a conventional unit. This results in very rapid inking up, and very few startup sheets are required – just 10 to 20 depending on the print motif.

The result is that hardly any starting sheets are required – only around 10 to 20, depending

on the print motif. This means up to 90 percent less startup waste. The fact that no ink zone settings are required cuts makeready times by up to 40 percent. And the time saved increases press capacity by 25 percent, making offset printing competitive, even for short runs of only a few hundred sheets.

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# Folding brochures containing a “lucky cent”

Postpress – where a print product takes shape

In finishing, the print product takes on its final form and increases further in value. When it comes to cutting, folding, perforating, diecutting, wire binding, thread sealing, gluing of folding cartons or perfect binding – success is once again all about differentiating yourself from the competition. This is achieved by optimizing the end product in the finishing process or through specialization in niche products, e.g. gluing a “lucky cent” to check cards or inserting plastic gloves in folded brochures.

Or take the case of customizing a magazine. A database instructs the saddlestitcher how to put together the pages of a magazine. When it prints the address of the subscriber on the cover page, it makes sure that the angling advert appears at the front of the copy for the angler and the racing bike ad does not. The racing bike fan can read the bike shop ad when he opens the same copy of the magazine, whereas the angling ad, which he is not so interested in, appears at the back, if at all.

Heidelberg Postpress has three sites in Germany. Ludwigsburg, with a staff of 470 has 70 employees in research and development – develops and produces folders, deliveries, mailing systems and digital finishing products. Leipzig, with a staff of 290 has 55 employees in R&D – develops and produces saddlestitchers, perfect binders, thread-stitching machines, thread-sealing machines and folders. Moenchengladbach with a staff of 230 has 50 employees working in R&D – develops and manufactures sheet diecutters and embossing machines, as well as folder gluers for the packaging industry. Other production sites for small folders, saddlestitchers, perfect binders and a 100-strong sales division for punching and cutting machines for the North American dealer market can be found in Sidney, Ohio and in Nove Mesto in Slovakia. At the Eksjö site in Sweden, 100 employees develop and produce mailroom systems and components for newspaper production.

### A heterogeneous market

Heidelberg Postpress has traditionally been structured as a midsize business and differs from the industrial world of series press construction in many respects. Each site has full responsibility for its own development and products. Around 6 percent of sales income is spent on development. Development projects are processed in project teams in a similar manner to press development. All areas, from product management to service, are represented in these teams. The cross-departmental areas of Heidelberg development are regularly consulted and integrated into the process.

However, there are many special features to postpress. The finishing market is very inhomogeneous, and the applications used by press operators vary greatly. As a result, a wide range of different configurations are demanded by customers – from simple mechanical devices to presses that are fully integrated into the workflow electronically and use Heidelberg Prinect to store repeat jobs, enter operating data and send presetting data to the press.

## Folders and mailers – one in three machines is customized

The machine park in printshops and finishing companies is heterogeneous, with a long service life. Consequently, the mechanical and electronic compatibility of the machines, above all folders and mailing units, must be guaranteed across generations and it is also essential that they can be combined with units from other manufacturers. To ensure this, we have to enter dialog with competitors about interfaces.
The functions and precision requirements of a press are considerably more complex than a folder. Nevertheless, folding is anything but a straightforward matter. One in three machines is customized. Similar rules apply to the construction of these special machines as to the customized printing presses. Postpress is a broader area, with a more decentralized structure. There is greater freedom and thus also greater responsibility for individual developers. In addition, the decision-making paths are shorter.

## Heidelberg standard for supplied products

A calculation is required to determine whether or not an in-house development is viable. Occasionally, the quantities or market potential of a product are not large enough to justify the development costs. Or the development does not involve core areas of expertise or unique selling points for the company that is adding the product to its portfolio. In this case, the alternative is an OEM (original equipment manufacturer) product – machines or components that are procured from other companies but distributed under your own brand name. Heidelberg also has machines of this kind in its portfolio.

Heidelberg's development department works together with developers from the partner company to certify the machine in accordance with Heidelberg standards. In other words, the procured product is exhaustively examined. All the requirements are subjected to rigorous examination, from the precision of the individual parts and the performance data of the complete machine to the reliability of the supplier, thus ensuring that the product meets the standards required by Heidelberg's Quality Gates.

## Dymatrix premium diecutter

The special challenge with the Dymatrix 106 premium diecutter lay in the technical adaptation of an existing machine, and its full integration into the Prinect workflow and inclusion in the Heidelberg design, which was developed in a record time of six months in cooperation with the support departments in Heidelberg. The development team in Mönchengladbach pressed on with the software and hardware, while the Heidelberg cross-departmental teams Simulation, Product Reliability, Drive Technology and Design contributed their know-how and

support from the outset. This included the integration of components from the Heidelberg product family such as the rake in the delivery for the continuous removal of the punched copies from the upgraded Dymatrix delivery.

Electronically controlled front and side lays ensure quick and precise feeding of a wide variety of materials. The diecutting plates are securely held by vacuum to enable precise creasing and diecutting. The patented gripper assembly register system ensures extremely accurate register. This is because the register system is integrated not only into the feed and cutting stations, but into the stripping and copy separating stations too. The tiniest pieces of waste can be stripped longitudinally and transversely in the stripping station.

For enhanced separation of the sheets from the pile, the Dymatrix uses a new anti-static device. Ionized air prevents static adhesion of the sheets. The diecutter and the pallet station can be integrated smoothly into the standardized logistics system from Heidelberg.
The Dymatrix can communicate with the Prinect tools via the integrated JDF interface. As a result, the finishing process is integrated into the Prinect workflow. The terminal operator can call up the job data, and at the same time the machine status is sent to the management information system in finishing. As a result, the operator and management have up-to-date planning boards.

## Folder gluer

Presented by Heidelberg for the first time at drupa 2004, the Diana X 135 is a completely new generation of folder gluers that boasts a new safety and automation concept and integrated gluing and quality control. The machine is set up using the AutoSet positioning system. Production data is stored to enable the machine to automatically position the upper and lower roller rails to the correct location in the case of a repeat job. This saves time, especially when working on a complicated packaging assignment. The system is connected to the Prinect workflow via a JDF interface. It processes board for folding cartons with grammages ranging from 200 to 900 gsm and various grades of corrugated paper. Depending on the application, it can reach speeds of up to 650 meters (2130 ft) per minute. At these speeds it can process up to 200,000 cartons per hour.

## Saddlestitchers and perfect binders

The Stitchmaster ST 400 saddlestitcher is newly developed by Heidelberg for industrial brochure production and features a central control unit with touchscreen display. It can also be controlled locally at each unit. The control unit for product monitoring, diagnosis and quality assurance is JDF-enabled and therefore integrated in the Heidelberg Prinect workflow. Presetting data can be transferred from prepress to finishing, data stored in job management can be called up and the makeready times reduced for new jobs. The digital workflow is supported all the way to management level for integrated job management and entry of operating data.

Another example of upgrading existing machines in line with the Heidelberg quality standard and corporate design is the Eurobind perfect binder series, which was developed to meet a wide range of automation requirements. These high-end models are controlled from a central control panel which is linked to the Prinect workflow via JDF.

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# Calculating, testing, designing and documenting

Engineering Services provide measuring and printing technology and do a comprehensive check of all components

Can the gear withstand the pressure at this point? What is the best angle for the air nozzles in the sheet guide plate to allow the sheet to be transported smoothly to the next printing unit? It would take years to run practical tests on every single component and every setting of a press. And by the time the tests were finished, the technological development of the component would probably be outdated. To achieve meaningful results quickly, extensive calculations and simulations are carried out in the early stages of a development by the Engineering Services team.

The cross-departmental team of Engineering Services, which has a staff of around 90, supports the product lines – from sheetfed offset presses of all format classes to prepress and finishing – by contributing its expertise in specific specialist areas. Sometimes team members are tied in for the full duration of a project and sometimes they work on several projects for different product lines at the same time. The wide range of applications ensures that developers increase their know-how systematically and can use solutions in other projects.

**Simulation or practical test?**

In the area of press and printing technology, tests are occasionally carried out virtually. Special computer programs provide results on a purely mathematical basis. Using statistical series or graphics on the monitor, the developer can identify how much stress a particular component is exposed to and if it can withstand the required loading over time. He can check if there is any expansion or deformation that restricts the neighboring gears and the precision of the processes. The scientists use reliable material values that indicate e.g. elasticity or transversal contraction.

If a machine such as the Speedmaster XL 105 is constructed completely from scratch, with new dimensions, performance characteristics and requirements profiles, hundreds of design calculations are run simultaneously. A flow simulation using the delicate paper involves a particularly complicated calculation model. To conduct this simulation, the research department works together with universities in Germany and abroad.

Inking unit tests cost a small fortune when practical test series are used. The new Heidelberg Hycolor inking and dampening system was therefore optimized over several months using detailed simulations on a computer model in order to achieve an extremely homogenous film of ink on the paper. Suitable measuring equipment and simulations must first be designed for many of the tests.

**Tests are also tested**

The experimentation techniques are also being continually enhanced, which increases the efficiency of the test methods, reduces the number of tests that have to be conducted, and saves time and money over previous methods. “Design of Experiment” (DOE) plays an important role in every project. After all, the quicker the development – no matter what the area – the greater the time and competitive advantage for the new product on the market.

When the mechanics/measuring technology department develops gearing, the position of the screen dots must be accurate to within a few µm. This means that the mechanics team needs to be exceptionally precise in crucial areas, such as the precision from one revolution to the next. The material must not show any signs of fatigue, even under a permanent load.

*Test print sheets are also developed by Engineering Services*

Any slippage or play within this finely tuned instrument would undo these efforts to increase precision. Acoustic and vibration tests ensure that the overall structure of the press remains rigid. They must take into account sound emissions and emissions that may affect the press operator and to which statutory thresholds apply.

A global player also has to comply with special environmental requirements, which cover everything from heat recovery to minimization of the alcohol concentration and noise level reduction. Worldwide legislation is entered in an internal Heidelberg database and taken into account in new developments. After all, 10 to 20 new laws, law changes or environmental regulations come into force every week across the globe.

**Three-year endurance test**

Despite all the computer calculations, practical tests are still a must in series press manufacture. These are used to check all manner of different components. An average of around 200 test stands is in operation at any one time, some of which have been developed specifically for these tests. Thanks to the use of cutting-edge tools and equipment, test logistics is even capable of producing new components overnight which are used for testing and optimizing mechanical components, thus enabling continuation of the tests the next day. The research team is supported by test logistics, which looks after the receipt of incoming goods, storage and test jobs and in so doing manages around 40,000 test parts a year.

In the servo drive and pneumatics laboratory, for example, electric motors are simulated with loads of up to 150 kW. Because press drives have to meet tough requirements, Heidelberg develops the power electronics for the motors in-house. Each sheetfed offset press has a main drive. Both it and the subsidiary drives must be completely reliable and allow absolutely no vibration.

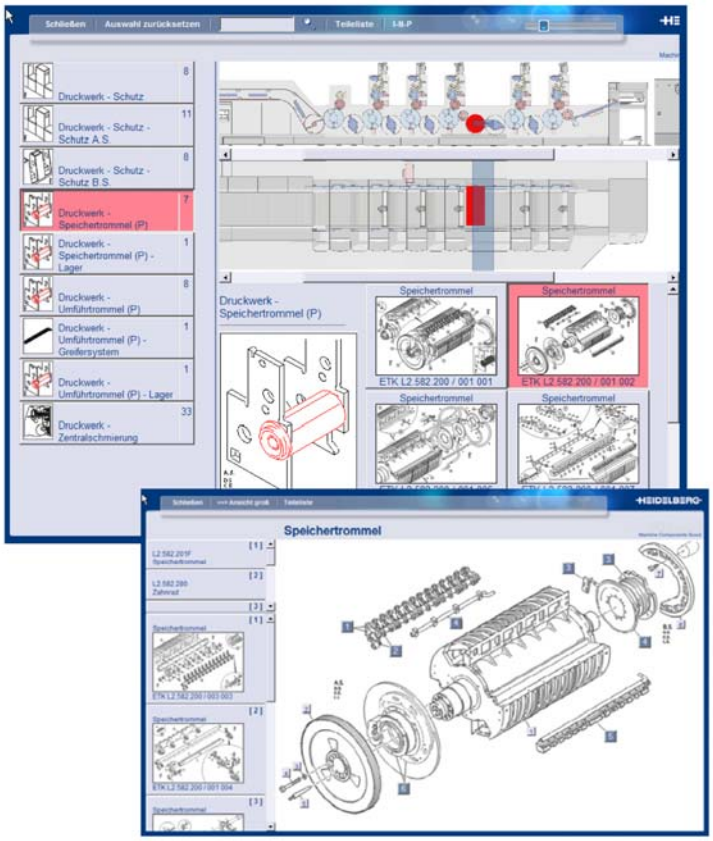
The electromagnetic compatibility lab checks whether interference fields stray from components into the vicinity of the press or if such fields stray from the press into the surroundings and prevent e.g. radio reception. The aim is to design assemblies and define rules for the printed circuit boards in such a way that interference fields are minimized. In the electronics laboratory, the assemblies – all manufactured in-house by Heidelberg – and their functional integration are put under the microscope. Quite literally, that is. In addition to performance tests, some of which are supported with real-time simulations, technologies are analyzed by electronic and mechanical components using light and scanning electron microscopy.

*Heidelberg has its own EMC laboratory, where it carries out its own tests on all electronic components and systems.*

Basic tests on dampening and inking, the creation of mathematical algorithms for controlling ink and dampening and the development of quality assurance tools are all crucial in printing technology. Sheets are specially combined in line with specific parameters to give the measurement engineers a precise evaluation of the print quality of an inking unit

Of course, the complete presses also undergo performance and service life tests. They are wired up as in a cardiogram, and have to prove their stress capabilities in endurance tests that are run through the day and night. Print oil is used to simulate the ink transport, as ink would dry very quickly. These service life tests take years. The press has passed when it has successfully completed 20,000 hours in operation.
Whereas the activities of the cross-departmental teams described thus far have largely involved product development, documentation is closely linked to service.

In addition to operating instructions for customers and service instructions for Heidelberg engineers, spare parts documentation also plays an important role. Spare parts documentation enables Heidelberg service personnel and the customer to precisely identify each and every part. The user-friendly system sends the digital assistant “McScout” on its way to search for the required spare part. McScout uses its X-ray vision to zoom into the interior of the press by exploding the view until it finds the required spare part and number.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Speichertrommel

As soon as the functional prototype of a press such as a new Speedmaster XL105 enters field testing, fitters have to be assigned to assemble and manage the press. Documentation and Heidelberg service personnel work hand in hand at this stage. Training documentation is used to train engineers in time for the press roll-out. The spare parts list appears in digital form, whereas the first version of the press operating instructions – which is translated into several languages – is issued to customers in printed form.

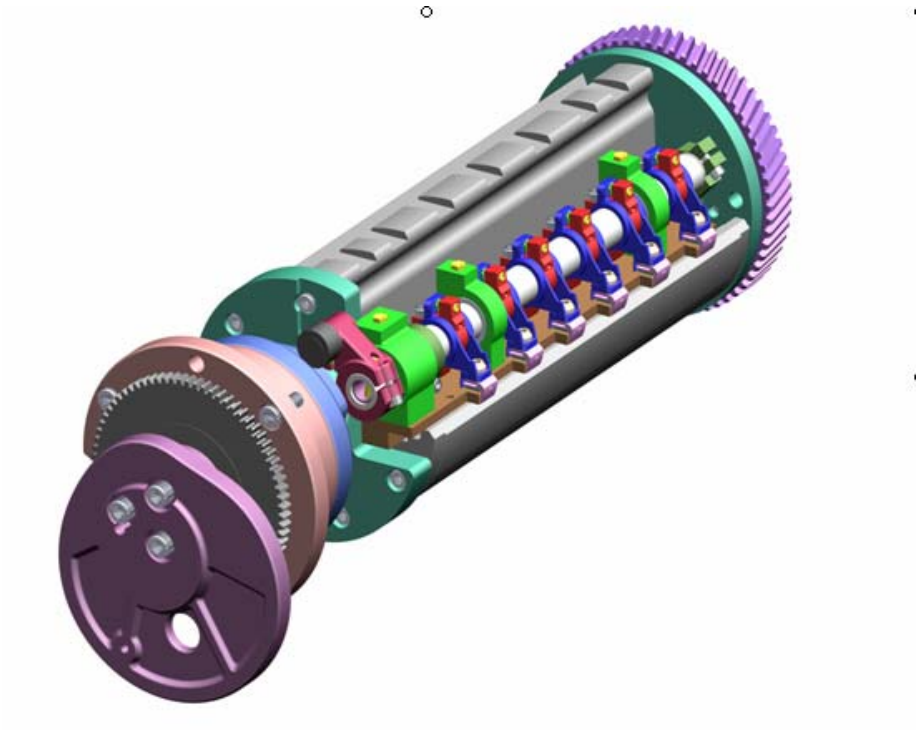
Press data can be called up and analyzed via remote service even during the first installations of a press, and it is possible to perform troubleshooting via remote maintenance. This tool is a tremendous aid, particularly at this early stage when the press has not yet attained

series robustness. This fact has been recognized by the industry. In 2005, Heidelberg won the IT Application of the Year award from the IT magazine Computerwoche and the consultants Gartner Deutschland for its Remote Services project. In 2004, TÜV Informationstechnik GmbH (TÜViT) also praised the reliability of the Internet-based remote service platform.

## The virtual press – accelerating innovation processes

3D CAD enables the creation of virtual 3D assemblies on screen – thus providing IT support for research and development

Complex solutions require comprehensive, high-performance development tools. 3D CAD provides developers with a wide variety of functions for creating and modifying components and assemblies. Virtual, 3D assemblies from other areas such as calculation, production planning, assembly, marketing or technical documentation can be introduced into the development process at an early stage.



*Simulation of an assembly*

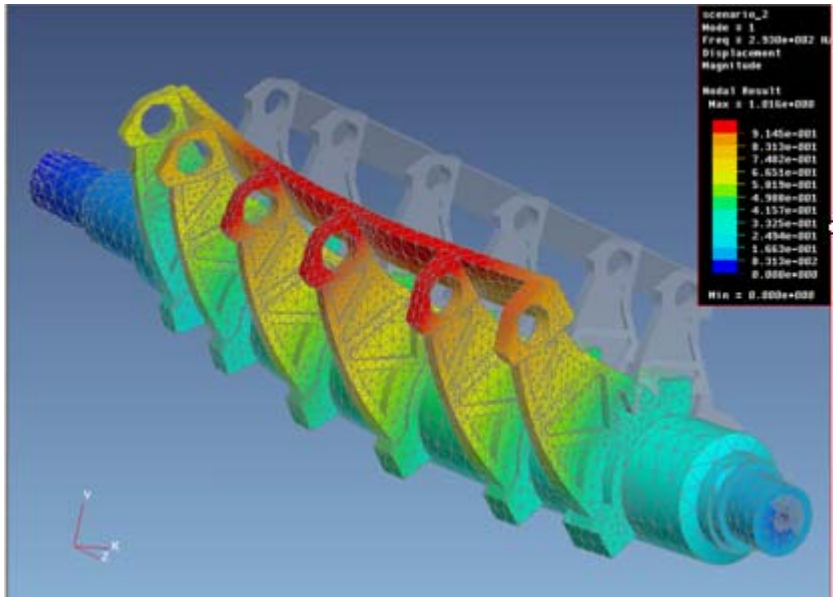
A 19-strong team is on hand to support the operation and implementation of the complex, innovative IT requirements. For example, the IT experts supply computers and programs that do not belong to Heidelberg's standard equipment but which are essential for research and development projects.

They provide storage space on a terabyte scale, special web or database servers, high-performance workstations and specific IT know-how in a heterogeneous environment. The IT team also ensures that the security conditions required to develop innovative solutions are in

place.

**3D – a new dimension**

A press consists of more than 100,000 parts. This sets a real challenge for a 3D computer-aided design system. It is extremely difficult to determine space requirements quickly in a two-dimensional sphere and thus to avoid collisions when the density of the construction increases. 3D CAM and PLM are powerful tools that enable all developers to access the latest developments. The SAP PLM system manages all the information required throughout the product life cycle of the press.



*Potential weaknesses are identified quickly, as in this finite element calculation for stress distribution in a transfer gripper*

The designer translates ideas into a 3D, virtual geometrical model using the 3D CAD system. Before any component is actually produced, calculations, assembly simulations, and photo-like depictions of the press and technical documentation are created. This enables potential weaknesses in a construction to be identified and rectified quickly. By varying the parameters or comparing alternative construction designs, the developer can find the ideal solution for a particular press function. This reduces development time while also assuring that the products attain the high quality standard.

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# Quality at first sight

Design creates recall value and strengthens emotional attachment

Design is the first thing you see in a press. The design of the press should reflect its performance capabilities. In other words, it should be high-tech. It should be immediately clear

that the product is a Heidelberg product and a premium one at that. Closer inspection of the details should confirm this first impression – through high-grade finishing, outstanding ergonomics and harmony of color and contours. Design creates recall value and engenders emotional attachment.

**History**

*Further development: Heidelberg is the design leader in the industry*

The design department is made up of nine personnel – six industrial designers, one media designer and one engineer – who work together to develop the corporate image for the entire Heidelberg product portfolio. In the 1980s, the company changed the look of its machines by introducing an integrated concept. At Drupa 2000, Heidelberg's revamped corporate design pulled off another coup with the new Speedmaster. It won countless national and international prizes for industrial design, such as the iF product design award (Hanover), the I.D.Annual Design Review (U.S.) and the Good Design Award (Japan), which substantiates Heidelberg's claim to lead the way worldwide in styling too.

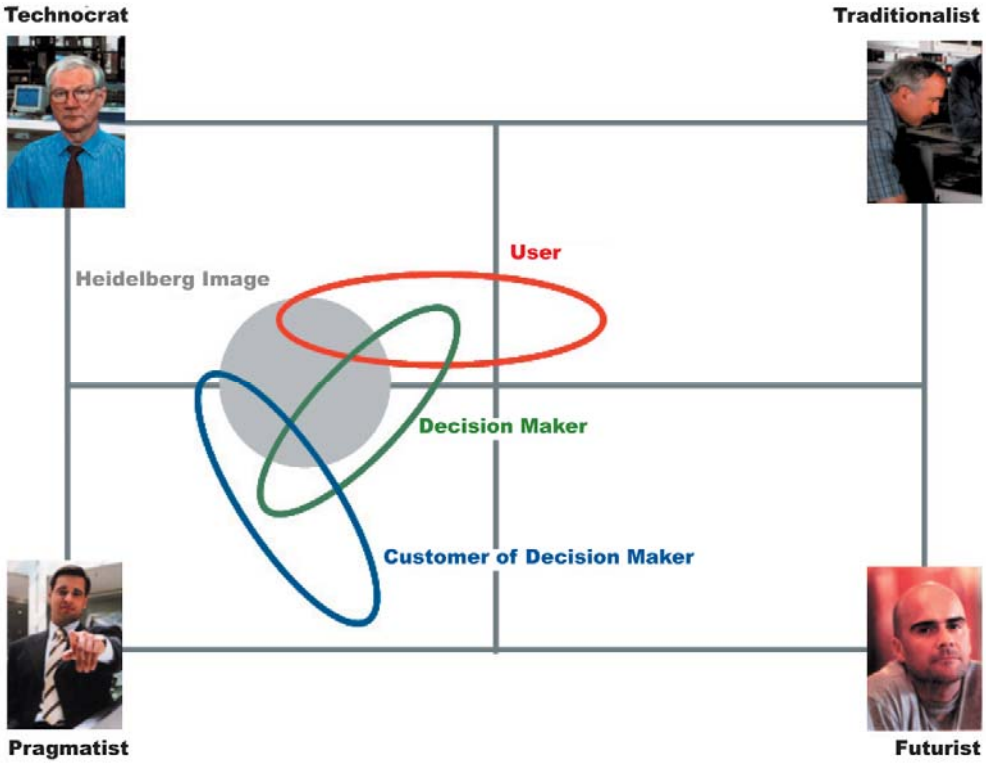
Design should not only appeal to Heidelberg's customers but more importantly to the customer's customers, for example when they visit the printshop to view operations or to okay a proof. Worldwide surveys show that good design is crucially important to printshop customers. Customers are convinced by a well arranged printshop and a press that represents quality and high tech.

**Describing design in terms of traditionalists and futurists**

Design has nothing to do with cosmetic appearance, nor is it solely a question of taste. Design is a clear means of differentiating a product – especially in narrow, fiercely competitive markets. Given the importance of design, "I like it" or "I don't like it" cannot be used by a company as reliable criteria for deciding how its products should look.

Special tools have been designed to enable descriptions of design, for example using semantics. This method uses four "types" to categorize the target groups of design. The "traditionalist" wants everything to stay the same. The "technocrat" is inspired by technical possibilities. The "pragmatist" is open, innovative and interested in the practical benefits. The "futurist" wants to break through existing boundaries and redefine form in the spirit of the times. Heidelberg uses the following grid to plot the ideal configuration for its products – outstand-

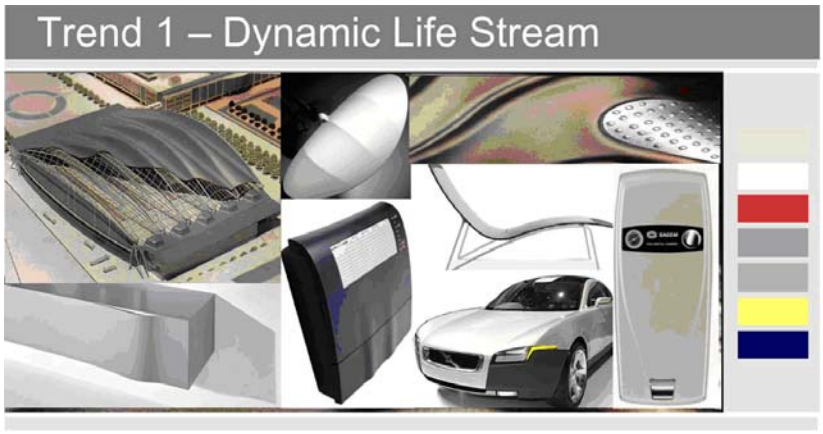
ingly high-tech, extremely practical, innovative and future-proof.




*The four types in product semantics*

**The “epitome” of high tech**

Heidelberg design characteristics with a high recall value include the cambered surfaces and the curves on the control casing which provide a thrilling contrast to the overall geometrical design. A special color tone, glittering mica silver, was developed to evoke high-tech. The Heidelberg logotype is blue, while the machines are predominantly noble gray. The nearer the machine to the office world, the lighter the color – presses, folders and binders appear in mid-gray tones, while platesetters are brighter.




*Emerging trend in architecture, automotive, consumer electronics, interiors, sport, commercial vehicles*
***Forms: taut, stretched, undulating, energizing, tapering and cantilevered, dynamic yet high-tech appeal***

The user interface must bear the same "signature" over the entire product family. The same applies equally to hand levers, handles and interface screens – everything that leaves the Heidelberg factory should carry the same hallmark and communicate high tech. Right down to the symbols on the control panel. The icons and abstract images on all the screens should be consistent. That way, operators that are familiar with one press series can quickly get to grips with all of them.

Design is a child of its time, and time is subject to change. The industry's world trade fair, Drupa, sets the trends for press manufacturers and the designs follow suit. The first products are already being designed for Drupa 2008. Every 10 to 12 years sees a break from the old. New visions are demanded, a paradigm shift is required – be it from angled to streamlined or subtly fluid. Heidelberg keeps its finger on the pulse by using trend filters and forming international collaborations with design agencies that specialize in trend monitoring. The aim is to create forward-looking, meaningful design guidelines for the entire company.

**The everyday business of creativity – creating the project profile**

**Start:** Each design project is first planned in cooperation with the product management and marketing departments. Which visuals appeal to which target groups? The focus at this stage is on strategic issues and costs, for example, whether to offer a product line or a platform in two different designs for two different working environments.

The ultimate objective is then set. Which customers form the target group? What will the operator use the machine for? How will he use it? What does the operator expect of his product? What are the ideal ergonomics? Which are the required technical dimensions? What is the competitive situation? What degree of differentiation is required? What do we want to communicate – quality, reliability, availability, trust, strength? Of course, the project profile also specifies deadlines and budget constraints. At the end of the day, the target costs must be met.

**Creating a concept**

The concept begins with a creative phase known as the "brain scribble". Designers produce hand-drawn sketches and collate their ideas. The creatives draw inspiration from everyday

products, from new car studies, or from architecture. A range of alternative design concepts in different styles are developed and then evaluated on the basis of the design strategy. The team picks out the best suggestions from the mountain of ideas. The results are entered in computer simulations which are shown to the other departments involved in the development process. The ergonomics studies are then analyzed to determine the user-friendliness of the press system proportions.

**Implementation**
Alternative designs and colors are evaluated. The concept is varied. Implementing the design is a question of ergonomics, technology and costs. Then it comes down to the details, e.g. the buttons, logos, labels, electrical and mechanical control elements, and clarifications have to be made with engineers and developers. A wooden model is built on a 1:1 scale and it is possible to walk around the press almost as it would appear under real conditions.

**Transmission**
The project is submitted to the development departments in the form of layout and scale drawings. All the design-relevant details are defined and documented. The design is supported right through to series production and fine-tuned again if necessary. A design check on the functional prototype is carried out as part of the Quality Gate 5 assessment, and the design is released. The company can now apply for protection of the registered design and take part in design competitions.

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# Inking is (not) an art

Press-related software – what goes on behind the touchscreen

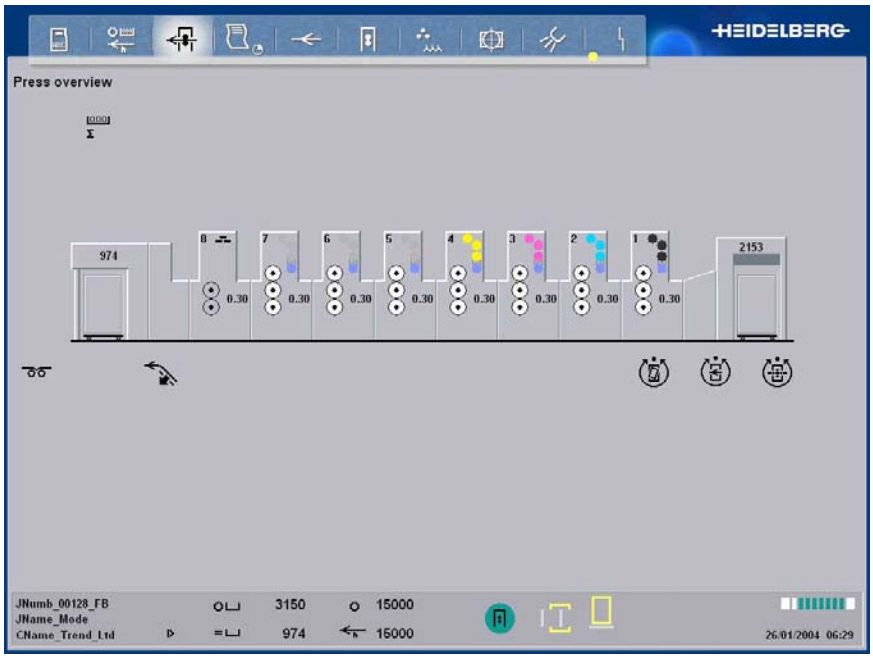
A button is pressed. The press is ready. Another button is pressed. Operation begins. The machine starts. Another button is pressed. A bell sounds. The first sheets are transported to the printing unit. And then the press fulfills its actual function – applying ink to paper.

The “press-related software” department does more than simply manage the processes behind the touchscreen of the Prinect CP2000 control console when the operator touches the operating panel on this interface to the press system. Smooth inking is an art – and a science – in itself. Not only directly on the press, but also in the integration of all the processes into the printshop’s digital Prinect workflow. Intensive tests and simulations assure the quality of the various products and guarantee they interact smoothly.

Electrical engineers and physicists program the real-time software for controlling valves, drives and feedback systems, indeed everything that takes place directly on the press, feeder, printing units and delivery. And when a machine such as the Speedmaster XL 105 appears – with totally new performance characteristics and dimensions – several thousand sets of commands have to be modified or reformulated in close collaboration with the mechanics, electronics and process development teams.

## Press operation – interface to the printer

The CP2000 is modern user interface that incorporates the very latest developments in ergonomics. A touchscreen has the flexibility required to adapt almost 200 masks and menus ideally to the printer's requirements. The different user interfaces are adapted to the various press types and prevailing working situations. The design parameters are the shape of the screen layout, the size and appearance of the buttons, the hierarchy of masks and the design of the graphics, symbols and language elements. The CP2000 is currently available in 26 languages, ranging from German and English to Chinese, Greek and Lithuanian.




## Process automation – controlling technology

Stop and start sequences, automated and programmable washup programs, self-learning characteristics, sheet reversal changeovers or automated job completion are just some examples of the procedures characterizing a complex production press.

Many conditions, job data, press status, production environment and current events must be determined and processed and evaluated in the software before a subsequent processing step can be introduced in an automatic workflow. Semi and fully automated workflows save the printer from having to perform repetitive, identical or similar process steps again and again.

In addition to the automated processes, many secondary closed-loop steps, such as the sheet arrival, the flight path of the paper, paper travel and filling levels also form the basis for controlling innovative complex technology. Our engineers require in-depth expertise in automation technology, and above all detailed knowledge of workflows and usage profiles for

Heidelberg presses and systems. Ultimately, the developers should be capable of translating these workflows into software programs.

## Color measurement and control – a core area of expertise at Heidelberg

Color is not inherent in objects. It is created when these objects absorb light, some of which they soak up and some of which they reflect back as the colors in the “rainbow” spectrum between red and blue. When the visible light meets the retina of the human eye, it triggers sensory stimuli of varying intensities in the sensory cells that are sensitive to red, green and blue.

Ink is a substance designed specifically to trigger particular color impressions in the human eye. While conventional printing procedures use a densitometer to measure the thickness of the ink coating in color measurement, Heidelberg uses a spectrophotometric measuring technique. The color is measured in the same way that it is perceived by the human eye. This is essential for ensuring high-fidelity color control – as patented by Heidelberg – in the press throughout the entire production run.

*Prinect Image Control*

Heidelberg’s special development know-how lies in managing this color workflow all the way from the original through to reproduction in sheetfed offset using hardware and software. This is a question of measuring color in accordance with defined standards and ultimately to control the press in such a way that it leaves the precisely desired color impression in the eye of the beholder. After all, automobiles in a brochure should be shown in their original color – and not only on the first few sheets.

### One touch of a button triggers a whole host of commands

The color values have to be maintained within a particular tolerance range throughout entire runs of up to tens of thousands of copies, using finely tuned closed-loop systems. The challenge is to understand the underlying physical relationships, to reproduce them using mathematical formulae and workflow diagrams then to implement them in closed-loop sys-

tems and technical solutions. This can be appreciated by every PC user who uses different scanners, monitors or color printers to create his document and sees the range of color casts that result.

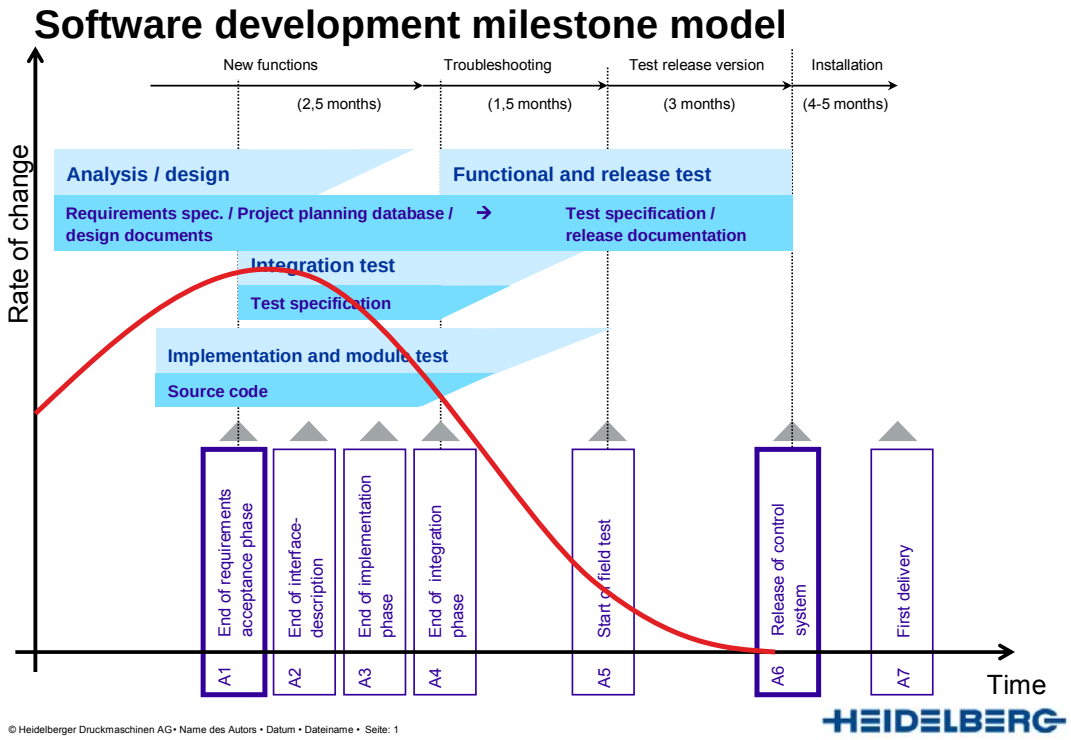
*The touchscreen interface on the Prinect Image Control*

Prinect Prepress Interface supplies the presetting data for the ink zones on the press from the area coverage values of the individual color separations. How much ink do inking units have to supply at a particular point in order to attain the optimal ink application on the sheet? How should the ink zones be positioned? A control sheet is pulled following the first print sheet. Image Control scans the interface and measures the wavelengths of the color in different areas of the sheet. These measured values are compared against the target values. The system calculates the deviations between the target and the actual color values and displays them on the touchscreen. The printer can then increase or decrease the color values at the touch of a button. Behind this button lies the concentrated control intelligence fed into the system by developers. A simple touch of a button on the Prinect CP2000 touchscreen can trigger a whole host of commands, setting countless “adjusting wheels” in motion. For example, in the 8-color XL 105 press, 256 ink zone drives are adjusted simultaneously.

**Software integration and qualification**

At the touch of a button, the printer can set all the functions in motion when starting the press, including the feeder, suction head, gripper, inking unit, dampening unit, cylinders, perfecting device, coating unit and delivery. The printer can activate or deactivate printing units and coating units, control colors, remotely control the register, activate washup programs, switch the inking rollers on or off, adjust the printing speed, rotate the plates out of the press after the print job, enter all the press operating data, make the dryer settings and adjust the blast or suction air. Close cooperation between all research and development departments is required to achieve the optimal interaction between the hardware, software and mechanics. Washup, for example, is a software-mapped procedure that controls and interrogates many

electronic drives and sensors.




The development of press-related software versions takes place in rigid six-month cycles, which are further subdivided into milestones. For each version, an average of 280 requirements by product management, design, assembly and service have to be implemented. Around 120 modules or components are newly created or changed, at least 20,000 of the 150,000 files edited for each version, and modifications are made to at least 3 million of the 20 million lines of code. Finally, all the changes are incorporated in a software package. Qualification of this software involves the execution of 3,500 test cases – sometimes repeatedly – in each six-month period.

The speed of development gradually slows following the “End of Integration” milestone. The focus then shifts to qualification and troubleshooting. The software is prepared for series production. The complete press control can also be simulated for qualification and testing. A simulated virtual press is used in place of a real press. This is often all that is required e.g. for test automation – the automated processing of test cases.

Press-related software development is closely intertwined with the development of workflow software in Kiel. Modules that are developed in tandem are integrated into a single software package.

# The mechanics of bits and bytes

Heidelberg develops the control platforms for its presses in-house

The number of electronic components used in and around presses is growing rapidly. Automation now accounts for 40 percent of Heidelberg's development activities. Press construction is a special area of mechanical engineering and there is no control system available on the market that fully covers the full spectrum of components and functions required for it.

When it comes to the development of electronic components, automotive engineering and the consumer industry set the pace – though with completely different objectives and life spans. Products in the consumer industry have a particularly short life span. Within a few years their parts are no longer available, while products such as cell phones are replaced completely. In contrast, a press is an investment good that remain in operation for up to 25 years. Customers would be dismayed to discover that they had to stop operating their machine after 7 or 8 years because a particular electronic drive unit could not be replaced for lack of replacement parts.

For this reason, Heidelberg has an extremely deep range of development and production in the field of control technology. The development area known as control platforms comprises power electronics, system software, electrical drive technology and the selection and management of the purchased parts required for the control, such as drives and displays. This team consists of 85 experts, almost all of them engineers. The press-related application software – which implements the various press applications using existing "control modules" such as control of the inking-unit or main drives – is based on system software.

Simultaneously, project management looks to the individual hardware components used in the control system to provide the electrical equipment for the complete press. Which drive cards are required in the delivery? Which I/O cards do I connect them to? Which bus systems are used to connect the external peripherals, such as the powder spray devices? Which

areas of the press have to be fitted with safety fuses and sensors? How can these be integrated via a separate control channel?

**500,000 assemblies a year**

At Heidelberg, bits and bytes have long taken center stage. A special feature of press technology is the close interaction between mechanics and electronics – and the long life span of a sheetfed offset press. On account of the special requirements, Heidelberg develops and constructs its control systems in-house – albeit with bought-in components – and can therefore boast outstanding know-how and many unique selling points. The company manufactures around 500,000 assemblies a year at its Wiesloch site. That equates to about 100 million parts, which means the site operates on a similar scale to a midsize electronics manufacturer.

Sheetfed offset presses are large series products. This is one reason why it makes sound economic sense to manufacture the required automation components in-house, unlike the smaller machine series found in finishing. Regular benchmark studies reveal that Heidelberg control systems offer better value for money because they have been designed specifically to meet the requirements of a press rather than if they had been bought in. Another advantage is that in-house manufacture has created a consistent and integrated control and drive concept that meets every need from software and components to Remote Service and online press diagnostics.

**A reaction time of 1 millisecond**

Let us assume that the system is required to react in real time (from 1 to 10 milliseconds) from the touch of the button to the required effect. A press is crammed full of components. The parts must fit precisely in the required position on the press. For example, one electronic part uses a circuit board that is barely the size of the palm of a hand to control 16 motors in the ink fountain. No external supplier would be able to offer this packing density in such close integration with mechanics. This is a crucial competitive advantage for Heidelberg.

A lot is expected of the stability and reliability of control systems. Take the example of the dynamic sheet brake on the Speedmaster XL 105. High forces of acceleration are generated in the press to transport the sheet at speeds of up to 18,000 revolutions an hour. In the delivery, the sheet has to be decelerated down to zero quickly. This is achieved by special drives controlled by an electronic part no bigger than a credit card – a high-tech product designed and manufactured by Heidelberg.

There are up to 600 axes and up to 2,000 inputs and outputs in a sheetfed offset press. There is no room for error in such a huge mechanism that needs to run like clockwork. When a printer is working between the gripper pad rails, the control system has to ensure that the relevant drives do not move, or that they only do so in a controlled manner. The fail-safe drive units have a second processor that controls all the safety relevant signals of the control system via the field bus and which moves the drive to a safe status in the case of malfunction.

The system is operated via an industry PC with a Windows-based interface. Centralized

press control takes place in real-time on a conventional central processing unit developed in-house by Heidelberg. The automation components are connected to the CPU via field buses. The press control is connected to higher-level systems via Ethernet. This allows the press to be connected to a production network and the Heidelberg Remote Service system.

**Balancing act between mechanical engineering and electronics**

Unlike machine tools, sheetfed offset presses require a highly scalable control system. Instead of developing a made-to-measure control system for each press type – some versions of which can contain up to 16 printing units – Heidelberg chooses a system of multiple usage. The modular architecture of the control system is identical on all presses and is adapted to the relevant press version in terms of the number of automation components.

Where machine tools can normally be easily upgraded to new control systems, the control systems designed for presses have to last throughout the course of the press's long operating life. Heidelberg produces electronics with an intended life cycle of 15 to 20 years and must therefore be capable of supplying its customers with suitable replacement parts over a long period of time. This results in an ongoing balancing act between the life cycle of the mechanics and the life cycle of the electronics. This is another reason why the company chose to manufacture the components in-house. Although the electronics are manufactured in house, however, Heidelberg buys in drive units such as electric motors and peripherals from external suppliers.

**Updates every six months**

The control platform represents an electronic base. The applications that use this control platform should not be able to recognize a change of computer or part – just as MS Excel sheets can easily call up existing files in new versions of the program.

Around 400 changes a year are made beneath the surface, and there is a new software release every six months and a new master software release every two to three years. This master release is the new level to which the other program versions have to adapt, just like the DOS or Windows system on a PC. For example, MS Excel will still have to function even after the discontinuation of Pentium 2. These updates and compatibility requirements guarantee the long-term availability of the press, which in turn assures the long-term value of the press for the customer.

Statistics show that a modification of some sort is made every day, e.g. a new washup unit, a dryer, a new interdeck dryer, or another UV add-on. All of these modifications have to be integrated in the software, and each mechanics project adds to the workload of the electronics team. A generation of Heidelberg control systems for sheetfed offset presses that contains around 350 different assemblies has just been replaced. The new sheetfed control system has 80 components fewer, but offers much better performance.

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# Software architecture – an in-house library

A means of hosting technology advances in automation

Press control systems were less complex in the 1980s and it was relatively simple to maintain an overview of them. The installed hardware products and control units were bulky by today's standards. A 3- or 4-color press was considered "long". The first leap in technology began in 1989 with the launch of microprocessors, which increased functionality. The size of the control system was increased – an 8-color press became standard and the software system architecture was defined accordingly. Extensions were added to the architecture in a similar manner to house architecture, where the framework might be extended and a balcony or spiral staircase added.

This is fine for a while, until the framework cannot be extended any further. A new house is needed with strong foundations and additional room for future developments. Coordinating the different development strands of application software, control software, mechanics and peripherals is a real challenge. From an organizational point of view, developers and subproject managers remain in their own defined areas, while coordination is centralized.

**One for all**

The objective was to quickly develop a future-proof architecture that was compatible with the old and new presses. In other words, to construct the house from scratch while living in it. The underlying principle was to build a control system for all presses of all formats. The system had to be intelligent enough to recognize the platform on which it is based and to configure itself accordingly.

The secret of a successful development is to minimize complexity and use a reliable and familiar base system. From the mid 80s to late 90s, approximately 200 man years were spent developing the CP Tronic control system. It provided a basis that the new sheetfed control system could build on.

The project began in 2000. The functionality was extended step-by-step every six months and the architecture modified. The number of different electronic modules required was reduced. The finished version of the software package was ported to other press models. This was not simply a case of copying and pasting but instead required modifications to various parts, such as the control system of the pile motor for the "paper lift", which required 3 kilowatts in the Speedmaster XL 105 as opposed to a few hundred kilowatts in the Speedmaster 52.

**Pages and chapters**

Software consists of a huge volume of commands, such as "Add, transfer the value from storage location x to location y". The computer requires these details for particular storage

locations, so that it knows what to do, for example, which activity to set in motion when a particular button is pressed. The computer has to know whether to safeguard against the command, ignore the command or communicate the command (ready to go, process completed successfully) to another interface or storage location.

The software architecture ensures that the various sections of the program are combined into a whole. Lengthy, complex series of commands that are complete in themselves are merged into blocks, pages or entire chapters. In other words, the system architect can combine “old” pages to form new chapters and in so doing expand the library in the newly constructed house, rearrange it, or filter out pages or chapters that are no longer required. Now the library user not only has more space, but can also find his way around more easily.

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# Compressed air for printing – and a whole lot more

## Heidelberg relies on its development partners for peripherals

There are thousands of parts in a sheetfed offset press system – covering everything from the control box to the powder spray device – and it would make little sense to develop each of them in-house. Heidelberg concentrates its development resources on its core areas of expertise and unique selling points and relies on its development partnerships with supplier firms for the numerous electronics, electromechanical elements and peripherals it requires. The partners contribute their specific know-how in such a way as to meet the particular requirements contained in the performance specifications. They are subject to the same Heidelberg Quality Gates development process as internal developments and supply the released parts to the assembly line just in time or directly to dispatch.

The electromechanics and peripherals department is the team with the greatest number of external contacts. The developers are all highly specialized – physicists, sensor engineers, electrical engineers, precision mechanics, process engineers, aerodynamic engineers or mechanical engineers who are just as at home in the various disciplines as sensor technology, pneumatics, air flow technology, electromechanics and electrical engineering are on the machines. Areas of process engineering such as powder application, powder extraction, temperature regulation, dampening, drying, automatic ink feeding or the supply of washup solution are developed with partners and used in the presses as part of Heidelberg’s own “Star series”.

### Meeting Heidelberg’s quality criteria

This team of Heidelberg developers forms an interface between internal and external development. On the one hand it works together closely with the development team from the supply partner, and on the other with all the Heidelberg research and development teams involved in the project – from simulation to press-related software – to guarantee that the supplied components or systems, comprising everything from the quality standards to the spare

parts list and operating instructions are fully integrated into the Heidelberg world.

Wherever the kilometer of cable harness in the press system is wired to, it always remains this department's areas of responsibility – and that extends all the way to the control box. Sensor technology covers everything from simple switches that are opened or closed by a guard to the complete control device for monitoring sheet travel. Project planning, including the electrical engineering aspects, is conducted by a team of Heidelberg hardware and software developers.

The speed of development is accelerating as competition increases. This is one of the main reasons for the high rate of change. On average, two or three changes are made to the control box each day. Sometimes a power element is added or sometimes a screw is repositioned 5 mm or an extra cable fitted. Some of the changes are made immediately and some at six month intervals, in line with the milestones defined in software and hardware development.

Air is essential for a sheetfed offset press, especially in the feeder and delivery where suction is applied to the sheet or deceleration. Since sheet guide straps were replaced by air cushions and sheet guide plates controlled by nozzles were introduced, the significance of dynamic air supply and air control has increased considerably. With power generation reaching 50kW, 8,000 m³ of air is transported into the press every hour. This is kept at a constant and highly efficient level and is cooled in order to avoid overheating the presses and the environment.

**Each paper has its own airflow**

Developers had to take additional mechanical requirements into account when developing the new Speedmaster XL 105 – customers not only wanted to be able to set the functions that are controlled by air themselves but also that these functions are set automatically in accordance with defined parameters such as paper quality, printing speed and grammages or adapt automatically to target settings. To achieve this, around 100 electronic controllers and control devices were fitted to the three main compressed air supply tubes in the XL – containing processors that send feedback to the CP 2000 control station at which they are operated. This development project was turned into a series product during an 18-month development partnership that covered everything from the first requirements to the specifications, tests, simulations and software alignment.

*The air control valve, a new part for presetting and controlling the press*

As soon as Heidelberg's requirements for the project are defined, there is a kind of invitation to tender. The offers are evaluated in a points system that uses the criteria of purchasing, quality and development to assess price, performance and quality assurance. After the user rights have been clarified and the order placed, the development partnership starts in a similar fashion to an internal project. The control group circle and project team are formed, and trial tests and regular coordination processes are implemented with the aim of creating a product that can be used across the whole press series.

Usually, a particular company acts as the development partner and supplier for a particular part. Long-lasting partnerships have been formed across the years and these are regularly checked in benchmark analyses. In total, Heidelberg works together with around 100 development partners. For historical reasons, many of them are based in south west Germany, a hotbed of mechanical engineering. Heidelberg spends more than 60% of its annual purchasing volume of around €250 million with its 10 biggest supply partners. On average, three to four developers at each supplier are assigned solely to Heidelberg projects.

**The niche in the niche**

Printing is the process of applying ink precisely to paper. But it involves a whole lot more. The quality requirements made of print products are increasing. The use of coatings for protecting quality enhancement or special effects is in demand, as is film printing or UV printing. For that reason, the dryer – whether infrared, hot air or UV – is an important and high-grade component in any modern sheetfed offset system devised in development partnerships. Often, specific requests by customers for special developments, e.g. for UV drying on the underside of the sheet, provide the stimulus for development partnerships with manufacturers.

The transition from providing special equipment for a series press to a customized press is a dynamic one. There is an increasing trend among printshops to differentiate themselves from

competitors by installing a customized press for a special field of application in a niche sector. The view of costs in a customizing environment is different from series production, where every cent is significant. Overall, it is easier to optimize process costs by using existing, easily adaptable series parts than by focusing on the purchase price of the parts that fit precisely.

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## Workflow in action

Prinect, Suprasetter, Speedmaster XL 105 and Dymatrix: an illustration of the workflow – from customer data to the finished product – in the soup packaging sector

*A networked, industrially structured print media house has an end-to-end flow of material and data. Workflow systems such as Heidelberg Prinect simulate and control all the processes in the company. The job begins at the* ***business management stage*** *with the customer inquiry. The printshop performs costing and draws up a quote in Prinect Prinance.*

*When the customer places the order, a digital job ticket containing the basic data is created in the system. This includes the customer name, print material, format, size of run, grades of paper e.g. for the cover and the contents, printing on front and/or reverse side, inks, coatings, finishing, delivery date and delivery location. For example, an order for 500,000 soup packages made of 230 gsm card, printed on one side using the CMYK Euroscale colors and a special color for the company logo, surface finished throughout with a dispersion gloss coating, diecut, to be delivered flat directly to the assembly line at the food manufacturer's site, and as quickly as possible because the factory has an urgent deadline.*

### More labels on a single sheet

*The job is created in Prinect Prinance. It is now the turn of production logistics. The card has to be ordered. Is the special color in stock? What is the most cost-effective method of organizing production? 500,000 labels – that should not pose a problem for the Speedmaster XL 105. It can manage up to 18,000 sheets an hour and prints more labels, that is, more individual packages on a sheet than other presses. This equates to a productivity increase of 25%.*

*It also meets another important condition by ensuring high-fidelity color reproduction over the entire surface area and production run. After all, if there were any color deviations, the end customer would choose to bypass any soup with the "wrong" color and leave it on the supermarket shelf. Dymatrix is used for diecutting. This machine is well-suited to processing large formats. The management information system shows how much capacity is available when on particular presses. The relevant dates are reserved in production.*

*The customer or the agency it has commissioned provides the print data in PDF format and supplies a true-color original template. The* ***production stage*** *in the Prinect workflow begins*

*when the printing data is received and checked. The customer has online, remote access to the job data up to the start of prepress processing. The job is approved. When the job reaches Printready, the actual workflow software, it has reached the JDF channel ("Job Definition Format" is the common language for all integrated software modules).*

*The software components of Prinect Color Solutions optimize the color specifications for offset printing and ensure color fidelity within narrow tolerances. The Profile Toolbox supplies the software for creating ICC color profiles and monitoring the quality of the proof and print. Trapping uses an intricate overlapping procedure to prevent white flashes from appearing between different color fields.*

*The pages are impositioned in the Prinect Signa Station. That means they are positioned on the print sheet in the order required by postpress. A form proof is plotted out. This is a control sheet that reveals whether all the elements, color bars, register marks (a type of crosshair used to ensure the plates for the different colors coincide perfectly) and trimming marks have been depicted and positioned accurately. Following that, the colors are separated into cyan, magenta, yellow and key/black and the Pantone special color for the logo. There is a printing plate for each color.*

**Images become dots**

*In MetaDimension, the data is ripped, that is to say, the image data is converted into screen dots. The printing plates can now be imaged. The MetaShooter integrates the Computer-to-Plate technology into the workflow.*

*The Suprasetter platesetter is controlled by the Prinect workflow. It generates an image on the printing plate which is later printed onto the paper using ink. The first coated aluminum plate is automatically removed from the cassette. High-precision measuring devices determine the position of the printing plate in the unit. With precision accuracy of within one thousandth of a millimeter, the laser head developed by Heidelberg processes the 105-cm wide printing plate in less than a minute. The print sheet requires five plates for the soup package. The text on the plate, which is an oil- and ink-friendly surface, is heated to 400$^{o}$ C and hardened. The plate is then transferred to a development bath for about two minutes and then to a dryer. The soft areas become detached. The plate is now ink-resistant.*

*The Prinect Prepress Interface is the interface between prepress and the subsequent steps in press and postpress for presetting the ink zones, diecutter, folder and saddlestitcher. The Profile Toolbox adjusts the printing profiles.*

**The data is already programmed into the press**

*The printer can start operations from the Prinect CP 2000 station. The job is loaded. Inks and coating are filled. The size of the sheet and the thickness of the material are already programmed into the press. The ink zones in the printing units have already been preset. The aerodynamics of the press are programmed using profiles and are ready to supply the correct quantity of air required for suctioning and transporting the paper. The operator positions*

*the pallet containing the sheets in the feeder. This press is used in the printshop for printing thicker materials and is elevated by 90 cm to allow a higher pile to fit in the Preset Plus feeder. This cuts down on the time spent changing pallets. Not that it is difficult to replenish paper when necessary. The integrated rake grips the pile of paper like a hand and allows the paper pile to be changed over automatically without stopping the press.*

*With the aid of the semiautomatic infeed procedure, the operator clamps the plates onto the impression cylinder. A few minutes later, the "Ready to Print" status appears. Within a matter of milliseconds, a simple touch of a button on the screen triggers thousands of finely tuned commands to the complex mechanism of drivers, gears, signals and sensors. The Heidelberg Hycolor inking and dampening unit is ready to ensure optimal inking for this grade of paper and print image. There is a faint murmur, and the 15-meter long press begins operation. Another touch of the button is all it takes to increase the speed. All the parameters are automatically adjusted to the higher requirements.*

**Five sheets per second**

*A button is pressed. The paper travel begins. The patented suction head takes up the first sheet. Four lifting and five forwarding suckers transport the sheet. And then the next, and the next. Forwarding rollers convey the sheet from the pile to the table. Five control devices monitor for double sheets that might damage the press. This device offers such a high level of reliability that only the Speedmaster XL can process thick card at speeds of 15,000 sheets and above per hour. A suction tape increases the speed of sheet travel from 0% to 165% of the printing speed. Shortly before the sheet arrives at the first printing unit, it is decelerated to 35% of the printing speed. This ensures there is sufficient time to align each sheet to the front and side lays, even at a high speed of 18,000 sheets per hour or five sheets per second.*

*At the feed drum, grippers that are perfectly synchronized with the thousand simultaneous programs, movements and commands bring the sheet to the first printing unit. The precision is monitored by sensors. The inking/dampening unit, a completely new design, is temperature-controlled to ensure that it is ready for use immediately, it delivers effective results and avoids quality deviations even at high temperatures. The ink remains supple and is distributed optimally. The ink application can be controlled with absolute precision. If, for example, the logo applied to the soup packaging in the manufacturer's special color only covers a small area on the print image, the operator can press a button on the Prinect CP 2000 control station that instructs the printing unit only to draw fresh ink every fifth or ninth sheet, to avoid over-application.*

*The press is inked up immediately and delivers the first OK sheet. The printer pulls a sample and places it under the scanner bar of Prinect Image Control, the high-end color measuring system. Many defined areas on the sheet are evaluated spectrophotometrically. The measured data is then sent to the system and compared with the target values. The touchscreen displays any over- or under-inking. The printer can adjust the press at the touch of a button even when running at full speed.*

*If small particles of the card become detached, the printer can use the touchscreen to acti-*

*vate the Vario system. The dampening distributor cylinder slows down. This enables small hickeys to be removed from the dampening system roller and rinsed in dampening water. To ensure that the sheet does not scrape against the metal during transportation, it is transported on a cushion of air. The special nozzle geometry steers the sheet along the required flight path like an invisible hand. Sheet guide plates coated using nanotechnology repel ink. The paper suffers no scouring. The Prinect Auto Register module controls the register setting automatically. Continuous control circuits maintain the pressure within a narrow tolerance band.*

*If, despite this, two sheets reach the printing unit at the same time, the press automatically switches to emergency stop. The same thing happens if a member of staff accidentally steps into the feeder area when changing the paper pile. Light barriers ensure the press halts immediately.*

*The sheets travel through the five printing units at high speed. In the high-end coating unit, thousands of tiny cells filled with coating create the perfect protective layer. The functions and performance of the newly developed Drystar high-powered dryer, can be attuned precisely to the relevant combination of paper, ink, coating and sheet travel. In this way, the print product is prepared precisely for postpress. The sheet is still traveling at high speed. The aerodynamic gripper bars in the new delivery smooth the sheet in an Air Transfer System. The sheet brake quickly decelerates it down to zero. The sheet is powdered and it floats onto the pile to ensure that it does not stick before being accurately aligned by the sheet jogger. Gradually, the pile of finished print matter on the pallet grows and it can be switched automatically using the rake in the delivery.*

*The print job is complete. At the touch of a button, the printing plates are removed from the cylinders. The new washup programs in the Speedmaster XL 105 are just as easy to operate. This easy mode of operation saves time, and allows the next print job to be started quickly.*

*While production is running, planning continues in the management information system. The capacity utilization of presses in the various departments can be called up and status notifications can be used to ensure the delivery date will be met. All the data about planning and operational statuses at the various workstations is available in the Data Control production management system.*

**The packaging takes shape**

*The ink and coating have dried and the high-tech Dymatrix 106 CSB diecutter is ready. The sheets are transported directly to postpress without trimming. The punch perforating knives are set up in line with the number of copies and the position of the images on the sheet. Compucut has used the presetting data from the Prepress Interface to generate data for finishing. The Prinect FSC100 module integrates other data from the production and information system into the Prinect workflow.*

*The diecutter communicates with the Prinect Data Control production management system via a special interface. Repeat data for the relevant diecutting job can be stored in this sys-*

*tem and called up in future. The job data is loaded and varied on the press, for example when a tie sheet is inserted to prevent the pile with the punched-out copies from toppling over.*

*The Dymatrix consists of a feeder with sheet feed, a unit with a cutting station, a stripping station and a delivery with blank separation and can process card up to a thickness of 2,000 gsm. There are registers on each station to ensure that the sheet is processed accurately.*

**300 tons of cutting pressure**

*The feeder works in a similar fashion to a press. The sheets are taken up by vacuum, rapidly accelerated and transported at high speed to the stripping station via a chain drive, where the diecutters with the prepared knives are applied vertically with 300 tons of pressure and cut the required shapes in the paper. In the stripping station, the fragments are removed, the speed of the finished copies is decelerated with a sheet brake and the sheets are transferred to the delivery pile. The print products are finished and ready for packaging and dispatch.*

*The job now switches back to the business management side of the Prinect system, in other words, to actual costing, invoicing, and bookkeeping. The production process is also monitored. Were there any problems in a particular process step? Is there a high level of quality throughout? Do all areas work cost-efficiently? Will stock have to be replenished? Prinect software gives clear and detailed information about the status of operations – and that applies equally to single jobs and to the overall operational structure over a long period of time.*
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# Summary

Research and development (R&D) has the role of **providing solutions for competitive products** that meet market requirements, customer wishes and incorporate the latest technology. Heidelberg chooses its development projects on the basis of market research, discussions with customers, and cooperation with research institutes and partner companies worldwide. The aim is to organize the **innovation process effectively** to systematically produce new and increased customer benefit and to create unique selling points.

Heidelberg supports and integrates **the complete value added chain in sheetfed offset printing** – from prepress to press and postpress – and networks all the components involved in the process. A printing press consists of up to 100,000 components and sophisticated software for controlling up to 500 drive axes and 300 pneumatic parts.

To control these complex processes, developers have to understand a wide range of mechanical, process engineering, electronic, material-specific and physiochemical relationships. In total, Heidelberg employs a staff of **more than 1,400** in R&D, which is around eight percent of the workforce. These are mainly engineers, physicists, chemists, software developers, technicians, mathematicians and printers. This complexity calls for a sophisticated system of work division and excellent coordination.

The key responsibilities of **Product Lifecycle Management** (PLM) at Heidelberg are to utilize resources as effectively as possible and minimize risks. This documented process comprises all areas of the product life cycle, covering everything from the initial idea and the business plan to the finished product and ultimately the product‘s discontinuation. Each project must pass through Quality Gates. These are defined milestones for evaluating product maturity that decide whether resources are released for a particular development project or whether large-series production starts.

Research and development at Heidelberg is organized in the form of a **matrix**. The vertical areas consist of the **product lines** – the small-, medium- and large-format presses, prepress and postpress – that are charged with meeting market and functional requirements. The product lines are supported by the **cross-departmental areas of Automation and Engineering Services**. Their duties include managing extremely diverse innovation cycles for the machines and the software. Innovations are implemented every six months.

The staff in the **predevelopment** team seeks the technologies of tomorrow and verifies the technical feasibility of ideas. One success story is the predevelopment of compact, modularly designed laser heads – which represented a first at Heidelberg. It was developed to product maturity by **Heidelberg Prepress** in Kiel and marketed as the Suprasetter CtP platesetter. The Prinect workflow (the name is derived from the terms **pr**int and con**nect**), which was developed in the Heidelberg software house, is an **information superhighway for printshops** that networks all areas of the production process. Data from job creation and prepress is used for subsequent processes or repeat jobs, such as the presetting of machines.

When a cylinder diameter is increased by 10 millimeters or as with the Speedmaster XL 105

speed is increased from 15,000 to 18,000 revolutions, **product development** has to **design the press from scratch** – from its mechanics to its motors, side frames, gearing, inking units, sheet travel and electronics. Changes to a particular part may require changes to the most intricate details of the press system or to entire components, such as the development of a new inking/dampening unit. The technical requirements are described in a catalog. This catalog is used to record innovations, such as a guide plate coated using nanotechnology to aid paper transport. The development process is supported through the use of intelligent tools, such as computer-aided design that incorporates 3D models and calculation tools.

**Postpress** systems, e.g. folders, perforators, and diecutters, are not nearly as complex as presses. The main challenge is to manage the wide range of configuration levels, which cover everything from simple mechanical devices to fully electronic machines controlled as part of the workflow.

The cross-department area of **Automation** supports the product lines by providing services such as project management (e.g. electrification), press-related software, control systems for the machine drives and peripherals such as components for air supply. The number of electronic components used in and around presses is growing rapidly. Because of the special requirements in press construction, Heidelberg develops and constructs its control systems in-house and therefore has outstanding know-how in this field. For peripherals such as dryers, powder sprayers, processing systems, and control boxes, Heidelberg enjoys strong development partnerships, thereby enhancing its own core areas of expertise.

The cross-department area of **Engineering Services** supports the product lines by providing measuring technology and print technology innovations. It takes account of environmental regulations and product safety, and creates documentation for the Heidelberg service and production teams and operating instructions for customers. Simulation and endurance are important factors in development processes. If a machine or a part is constructed with new dimensions, performance characteristics and requirements profiles, hundreds of tests are run simultaneously, some using computer programs and some in real test setups. These monitor everything from loads, stresses and deformations to the flow characteristics of the paper and electromagnetic compatibility. Design is the first thing you see in a press. The design of the press must reflect its performance capabilities. In other words, it should be high-tech. Design creates recall value and fosters emotional attachment.

Ultimately, all the innovations must be turned into well-functioning products that bring customers commensurable advantages in the form of time savings, reduced wastage, increased benefits and greater speed. This is shown in practice by a Heidelberg example workflow that uses Prinect, the Suprasetter CtP platesetter, the Speedmaster XL 105 press and the Dymatrix diecutter.